ARIZONA GAME AND FISH DEPARTMENT

REVIEW OF

U.S. FOREST SERVICE STRATEGY FOR MANAGING NORTHERN GOSHAWK HABITAT IN THE SOUTHWESTERN UNITED STATES

Arizona Game and Fish Department
2221 West Greenway Road
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TABLE OF CONTENTS

EXECUTIVE SUMMARY

This document describes the Arizona Game and Fish Department's (Department) concerns related to the U.S. Forest Service management strategy for southwestern forest habitats used by the Northern goshawk (*Accipiter gentilis atricapillus*). Because the Department has management responsibility for all wildlife resources which would be affected by implementation of this habitat management strategy, the concerns presented in this document involve not only the goshawk, but also a broad range of wildlife species.

The Forest Service management strategy is based on interpretation and application of the "Management Recommendations for the Northern Goshawk in the Southwestern United States," (Reynolds et al. 1992) (MRNG) which was developed by the Forest Service's Goshawk Scientific Committee (GSC). Although the Department disagrees with some of the basic assumptions used by the GSC to develop the MRNG, the MRNG represents a significant improvement over previous forest management practices. However, subsequent interpretation and on-the-ground implementation of the MRNG has raised significant concerns about the impacts of this new management strategy on the goshawk, its prey and a wide variety of other wildlife species using southwestern forest habitats.

Many of the concerns identified in this document are reflected in one or more of the following issues:

- **The degree to which the forest structure in goshawk foraging areas should be opened.** Considering the goshawk's morphology, foraging behavior, habitat preference, potential competition from other raptors, and the habitat needs of goshawk prey, the Department believes that the forest should be managed at higher canopy densities than are now proposed in the Forest Service management strategy.

- **Application of the MRNG to lands allocated as old growth and lands designated as unsuitable for timber production.** Because of the unique wildlife habitat values often associated with these lands and the difficulty of recreating these values through silvicultural treatments, the Department believes that application of the Forest Service management strategy to these lands is inappropriate.

- **Cumulative effects of past, present and future timber harvest activities.** The MRNG will be implemented on current forest conditions, which are partly the result of cumulative effects of past timber management activities. The potential impacts of the MRNG on wildlife resources must be evaluated in relation to these past activities, as well as to present and proposed future actions.

- State agencies with legal mandates to manage wildlife, including the goshawk, were denied membership on the GSC. Because the GSC recommendations have direct impact on State responsibility and authority to manage wildlife, the Department continues to address concerns with the Forest Service management strategy to fulfill its legal mandate.

- Current interpretation and application of the MRNG is resulting in management at or below minimum thresholds identified in the MRNG. Since publication of the MRNG, the Implementation of the MRNG in upcoming timber sales has redefined or reinterpreted minimum thresholds set in the MRNG. These adjustments have moved toward a more open canopy and younger-aged forest.

- Replacement of Land and Resource Management Plan Standards and Guidelines with the Forest Service management strategy. The Department believes that wildlife Standards and Guidelines designed for species other than the goshawk can be maintained while still providing appropriate habitat for the goshawk.

- Proposed application of the MRNG on a landscape scale. The MRNG embodies a number of untested hypotheses. Until

INTRODUCTION

This document was compiled to promote a better understanding of the Arizona Game and Fish Department's (Department) concerns relating

the MRNG did address many long-standing concerns regarding management of goshawk habitat. The MRNG called for an extended rotation, consideration of each goshawk pair across 6,000 acre home ranges, silvicultural treatments of small blocks, uneven-aged management, retention of old trees on each acre, maintaining snags and providing downed woody material for wildlife habitat and nutrient cycling. These recommendations represent significant improvements over previous forest management practices and can provide benefits to a wide variety of wildlife.

Unfortunately, subsequent interpretation and application of the MRNG by the Forest Service (e.g., Implementation Guidelines), represent a substantial departure from what the Department believes was the original intent of the MRNG (Fig. 1). Minimum thresholds identified in the MRNG, as necessary to sustain goshawk

[redacted]

The MRNG includes Desired Future Conditions (DFC) for goshawk nest areas, post-fledging family areas (PFA), and foraging areas, in three forest types (ponderosa pine, mixed-species, and spruce-fir). The Department's primary concerns relate to the management of foraging areas in ponderosa pine because 1) most of the known goshawk territories are currently located in this forest type, 2) the foraging area makes up 90% of each goshawk management area (5,400 acres out of 6,000 total acres), 3) the Department believes that application of the Interim Guidelines and Implementation Guidelines for the foraging area will result in forest conditions which do not adequately meet the needs of the goshawk and other wildlife species, and 4) guidelines to implement the MRNG in mixed-species and spruce-fir forests have yet to be developed.

The first section of the document (Background) discusses the distribution, ownership, management and conditions of ponderosa pine habitats in the Southwest. It also provides an historical summary of the goshawk issue from the Department's perspective. The Forest Service's historical perspective is presented in the MRNG and Interim Guidelines.

The second section of the document (Issues Regarding the Assumptions of the Forest Service Management Strategy for the

BACKGROUND

Ponderosa Pine Forest Habitats in the Southwest

Distribution and Ownership

Ponderosa pine forests are widely distributed across the Southwestern United States, occupying approximately 3.4 million hectares (8.5 million acres) of Arizona and New Mexico (Brown 1982). Elevational distribution is typically between 1800-2400 meters (5940-7920 feet), on a variety of soils derived from igneous, metamorphic, and sedimentary rocks (Schubert 1974). In Arizona, the ponderosa pine type is concentrated along the Mogollon Rim, in transition zones between drier pinyon-juniper and oak woodlands, and more mesic Douglas-fir and mixed conifer types. Extensive ponderosa pine forests are also present on high plateaus in the northern portion of the state, such as on the Kaibab Plateau. In Arizona, ponderosa pine occurs as pure stands and in combination with hardwoods or other conifers. Hanks et al. (1983) identified four major habitat types, 12 phases and five community types within the ponderosa pine forests of Arizona.

Arizona has approximately 1.4 million hectares (3.5 million acres) of ponderosa pine forest, the majority of which (66%) are administered by the Forest Service, primarily by the Apache-Sitgreaves, Coconino, and Kaibab National Forests. Thirty-two percent of Arizona's ponderosa pine forests are privately owned and the remaining two percent are held in other public trusts (Conner et al. 1990).

Forest Management and Conditions

Man's influence on southwestern ponderosa pine forests began well before European settlement. Cooper (1960) cites a number of sources documenting widespread use of fire by Native Americans in Arizona and New Mexico. With the arrival of European settlers in the 1870s, ponderosa pine forests in Arizona were subjected to new influences, including large numbers of exotic ungulates, fire suppression, and timber harvest. These factors have played an important role in shaping current forest conditions.

Historical grazing practices had significant impacts on ponderosa...

surface fires with a recurrence interval of 2-11 years (Weaver

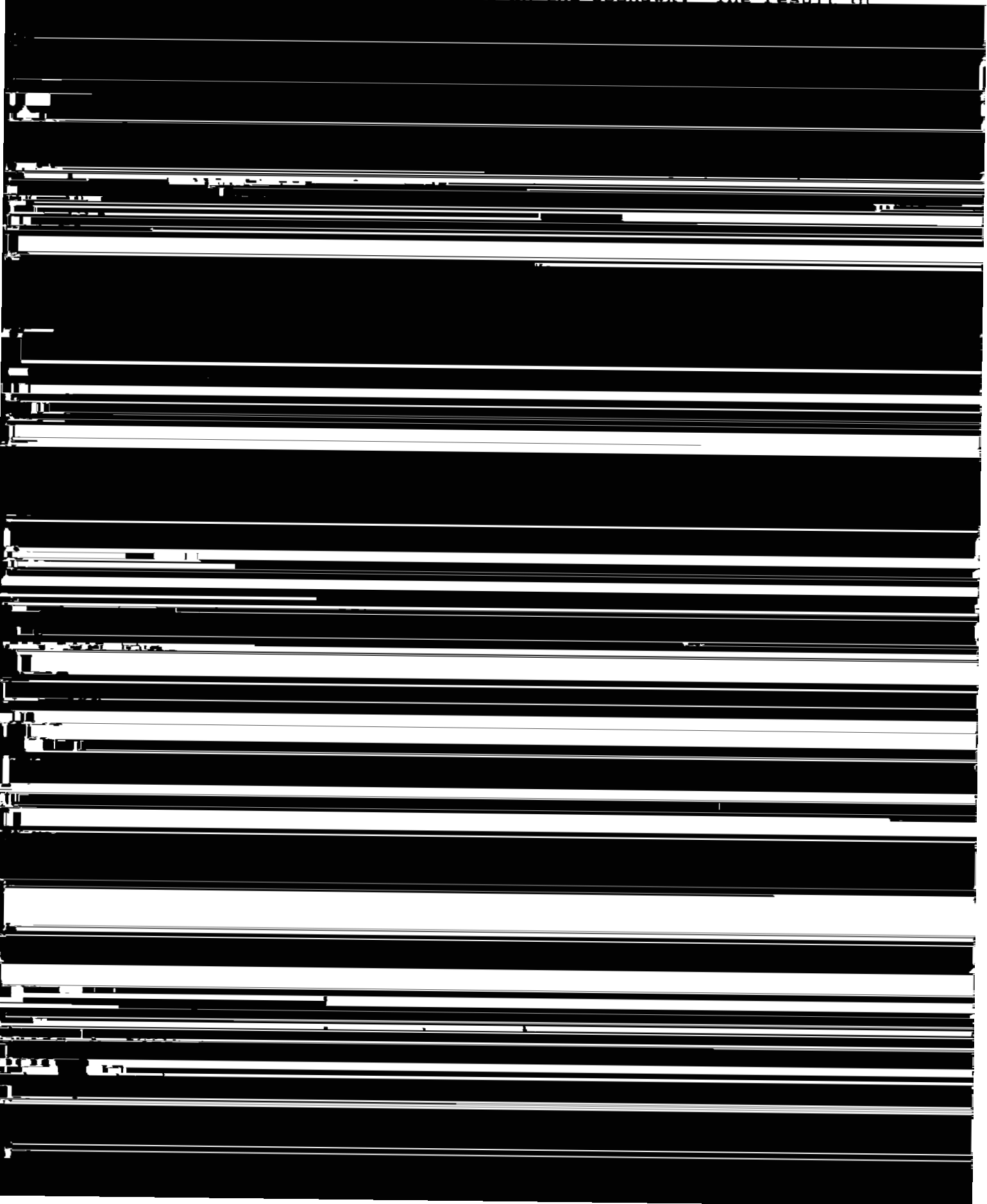
habitats essential to support the wildlife diversity found in Arizona's forests.

Intermediate-scale landscape patterns are difficult to define, due to indistinct and often "fuzzy" patch boundaries. Regional differences in management history are reflected at broad landscape (geographic) scales. For example, the area around Flagstaff was heavily railroad logged during the late 1800s and is now dominated by mid-aged (80 year-old) stands. However, the Kaibab Plateau, north of the Grand Canyon was not commercially harvested until the 1940s and is dominated by older stands of mature "yellow pines." Other ponderosa pine forests in Arizona represent stages of maturity and structural complexity intermediate between these two.

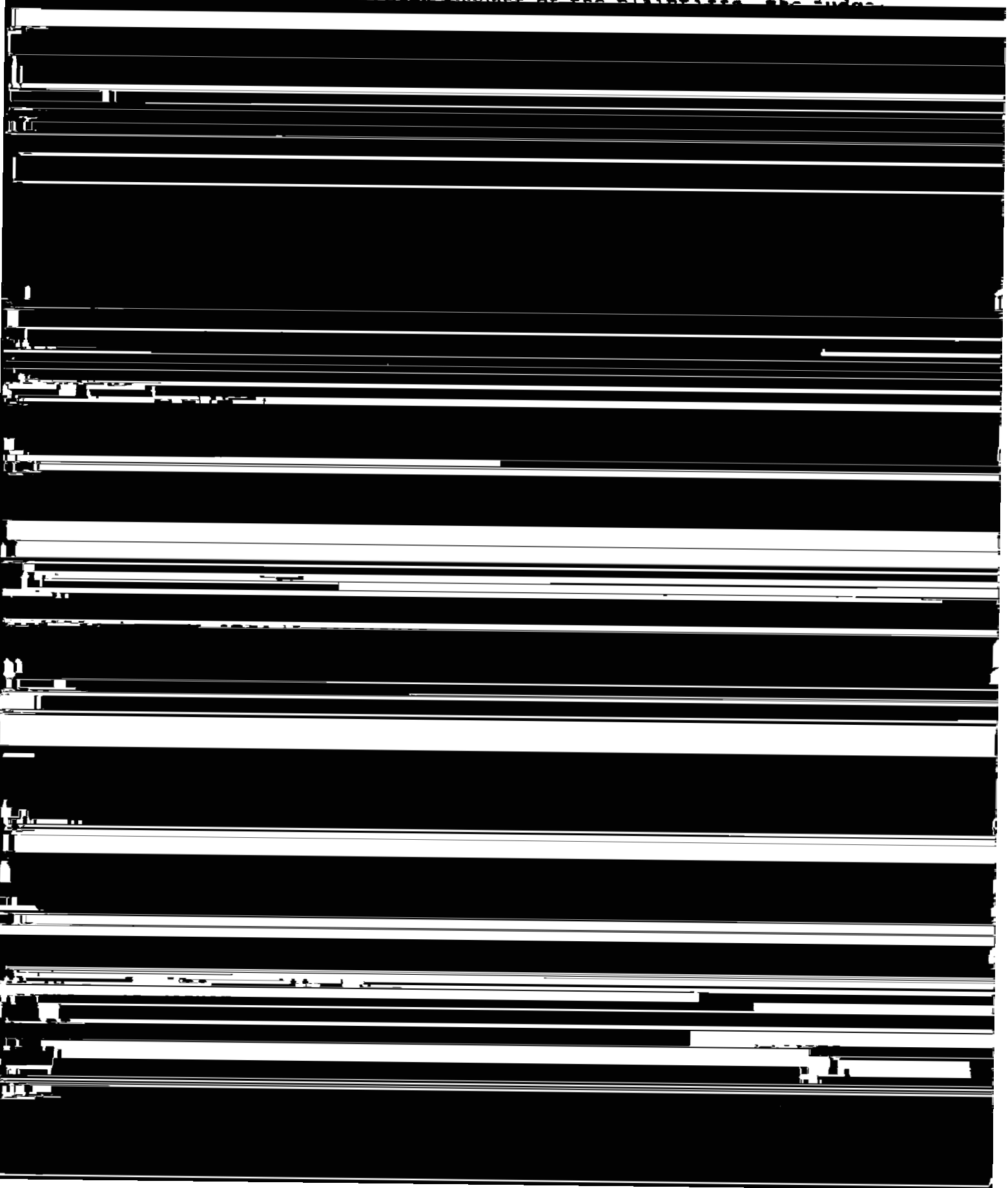
Historical Summary of the Goshawk Issue in the Southwest

Over the last two decades, concerns over changes in forest habitats in the Southwest and the viability of goshawk populations, which depend on these habitats, have been expressed by wildlife

As the body of knowledge grew, so did concerns over the status of the goshawk. In March of 1990, in response to a letter from several environmental organizations, the Regional Forester conducted an internal status review on the goshawk. The result of



Significant Impact were also issued as the NEPA compliance documents for these guidelines in October 1991. After the appeal was dismissed, the coalition of environmental groups filed suit in federal district court to stop implementation of the June 1991 guidelines. However, by the time the case was reviewed in November, the October 1991 revision had been issued, partially



In the Fall of 1992, when questions were raised regarding the public review and NEPA compliance process used for the Interim Guidelines, the Forest Service indicated that a supplemental EA and BE had been prepared in May 1992 to address management activities in the foraging areas. When the Department requested these documents, the Forest Service could not locate them and they were not provided to the Department until January 1993. The BE was dated January 19, 1993.

The Department, NMDGF and the USFWS continue to have concerns regarding the MRNG, the Interim Guidelines and their on-the-ground application. The Department's efforts to resolve these concerns are ongoing and include participation on a Goshawk Implementation Team with the other wildlife agencies and the Forest Service.

ISSUES REGARDING THE ASSUMPTIONS OF THE FOREST SERVICE MANAGEMENT STRATEGY FOR THE NORTHERN GOSHAWK

Assumptions Regarding Goshawks

The MRNG argues that the goshawk is a "forest habitat generalist" because goshawks occur in many different forest types (pine, fir, aspen, etc.). However, goshawks have evolved physical characteristics (morphology) that enable them to hunt most efficiently in relatively mature, dense forest structures. Therefore, the Department considers the goshawk a "forest habitat specialist" that is strongly associated with mature, dense forest

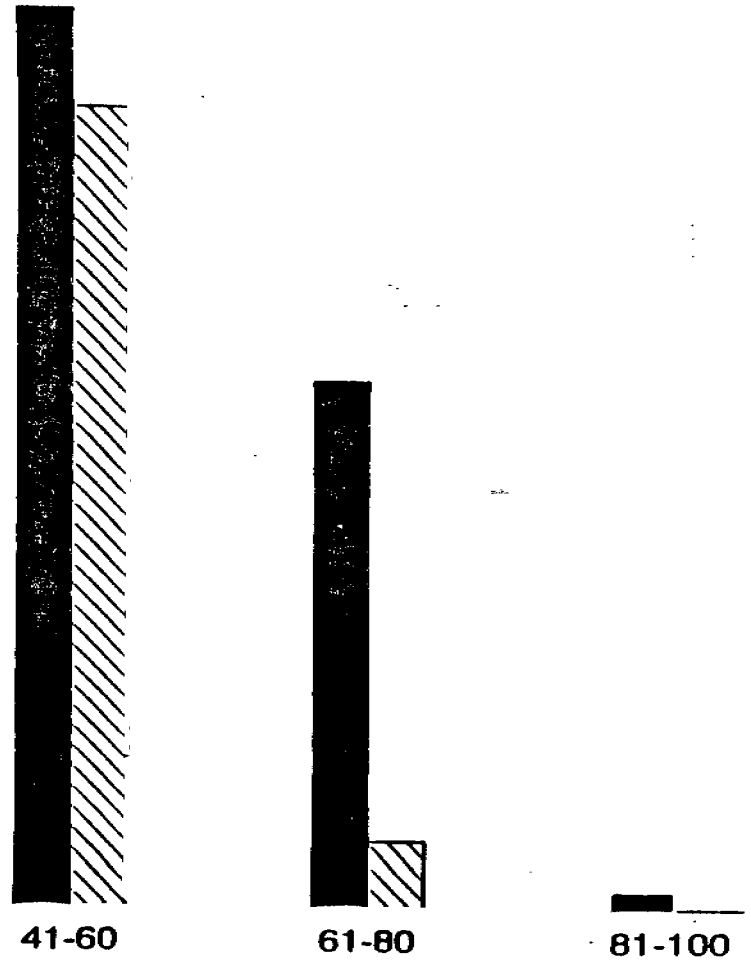
habitat (Brown and Amadon 1989, Cade 1982). The red-tailed hawk hunts by either remaining stationary on a perch for long periods or by soaring at a relatively high altitude. Both strategies allow it to scan large areas for unwary prey. Open vegetation facilitates this search. When prey is spotted, the red-tail can wait until the prey is most vulnerable, then drop from the perch or sky for the capture. The red-tail's morphology and foraging behavior are most efficient in open habitats where large areas can be searched from a few sites.

The Department and the authors of the MRNG agree about the morphological characteristics that give goshawks the necessary maneuverability to hunt in forests (Reynolds et al. 1992:10). However, the Department disagrees with the open forest conditions advocated in the MRNG and Implementation Guidelines for the foraging areas, since these conditions create a forest structure where goshawks cannot use their morphological adaptations most efficiently. This theme is central to the Department's concerns.

Smith and Mannan (in review) used radio telemetry to repeatedly locate male goshawks during the breeding season on the North Kaibab Ranger District. Since males capture prey to feed themselves, the nesting female and their young during this period, the male's use of habitat was assumed to reflect its foraging value. Smith and Mannan (in review) plotted the male's locations on maps showing different forest canopy cover classes (0-15%, 15-40%, 40-55%, and 55+%). They found that goshawk use of areas increased as the canopy cover increased. Smith and Mannan (in review) supported the MRNG's recommendation to leave 60% of the foraging area in stands with high canopy cover, but recommended the minimum canopy cover in these areas be increased from 40% to 55%. Smith and Mannan (pers. commun.) cautioned that final revisions may adjust this recommendation.

Austin (1991) found that goshawks selected the oldest, densest vegetation type available, and avoided the youngest and most open. Kennedy (1989) recommended that no timber harvest occur in a 415 acre area around goshawk nests and that canopy cover in the surrounding 1,185 acres (male core use area) not be reduced below 60%. Kennedy (1989:13) predicted that goshawks nesting in good habitat would have smaller home ranges than those using marginal habitat. "Major vegetation changes such as logging may impact Accipiter home range size by changing good quality hunting habitat to more marginal habitat" (Kennedy 1989:13). Kennedy's (1989) telemetry study found that a male goshawk's home range, in an area managed extensively for timber in recent years, was quite a bit larger than home ranges of males nesting in less managed sites. Kennedy (1989) found the same trend with home ranges of Cooper's hawk (*Accipiter cooperi*) males.

An examination of 38,300 acres of ponderosa pine, centered around goshawk nests on the North Kaibab, Ward et al. (1992) found that, between 1972 and the late 1980s, the percent of this area with less than 40% canopy cover, had increased from 10% to 46% (Fig. 2).



PY CLOSURE

from aerial photographs on 38,300 acres of ponderosa pine on
9. From Ward et. al., 1992.

The percent of the area over 60% canopy cover declined from 34% to 4%. Since the late 1980s, more thinning has occurred on the North Kaibab, further reducing the area which, according to Smith and Mannan (in review), is most used by male goshawks.

The MRNG advocates an open foraging area in ponderosa pine (40%+ canopy cover). The Implementation Guidelines propose a harvest scheme that will open the forest even more (approaching 30% canopy cover in the younger stands). Management for a **maximum** canopy cover level of 40%, over large areas, has been proposed in upcoming timber sales on the North Kaibab Ranger District (i.e., Paris and Holy Hollow Timber Sales).

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The Department and the authors of the MRNG differ in the degree to which the forest in foraging areas should be opened. Considering the goshawk's morphology, foraging behavior, habitat preference, and the potential competition from other raptors, the Department recommends most of the forest be managed at higher canopy densities than is now proposed in the Implementation Guidelines. The Department's recommendations are found at the end of this document (Arizona Game and Fish Department Recommendations).

Comparison of Productivity in Different Habitats

The Grand Canyon separates the Kaibab National Forest into two areas (north and south) which have very different habitat conditions. Despite heavy timber harvest in recent years (Zinn and Tibbitts 1990, Cassidy 1991), the North Kaibab still features an older aged forest structure. The South Kaibab received heavy timber harvest decades ago and is now dominated by a younger forest, much of which has been heavily thinned.

One measure of habitat quality is reproductive success. The Department made a preliminary comparison of goshawk reproduction data between the North Kaibab and South Kaibab. In 1992, on the North Kaibab, 51 goshawk nesting attempts fledged an average of 1.8 young per nest (Reynolds 1992). In the same year, 16 nesting attempts on the South Kaibab produced an average of 1.1 fledglings per nest (McGuinn-Robbins 1992). These reproductive rates were statistically different ($Z = -2.2$, $P > |Z| = 0.03$).

Although this is only a preliminary comparison of the two reproductive rates, it demonstrates the need for further comparisons of goshawk reproductive rates in different forest habitat conditions. In comparing goshawk habitat on the North

Assumptions Regarding Goshawk Prey

Prey Abundance

The MRNG assumes that it is beneficial to manage for open forest conditions in the goshawk foraging area to provide habitat for certain small mammals and birds. The MRNG also assumes that these birds and mammals will be available as prey for goshawks with open forest conditions. The Department disagrees with the assumed need to provide open forest conditions throughout the foraging area. The Department believes that mature, dense forests, where goshawks hunt most effectively, support a diverse prey base, and that goshawks capture prey opportunistically within the structural environment suited to their foraging behavior.

The MRNG states that as many as 50 species of prey are taken by goshawks, with 14 species dominating the goshawk diet in the Southwest (Reynolds et al. 1992:4). Thus, the GSC recognized the broad spectrum of prey available to and used by the goshawk as it hunts through the forest. The Department agrees that many of the prey discussed in the MRNG dominate the goshawk's diet. The MRNG's objective to provide an abundant and diverse prey base for the goshawk is desirable.

However, the MRNG's own analysis of prey habitat needs, shows that a relatively dense, mature forest contributed to maintaining high populations of most of the identified prey during the summer (Fig. 3). During the winter, which may be the most stressful time for goshawks to find prey, six of the 14 targeted prey species have migrated or hibernated, and are thus unavailable. Again, the MRNGs stated that in order to maintain high populations, seven of the remaining eight prey species benefitted from a dense, mature forest structure (Fig. 4), and one, the cottontail, requires cover. Yet,the Implementation Guidelines propose timber management at or below 40% canopy cover, a level which the MRNG shows will not contribute to high populations of most goshawk prey. Furthermore, the MRNG does not recommend that the entire goshawk foraging area be open, only that small openings ($\leq$ 4 acres) are valuable.

Smith and Mannan (in review), Austin (1991), Kennedy (1989), Hargis et al. (in prep.), Crocker-Bedford (1990a), Widen (1989) and Fischer (1986) have described the goshawk's preference for older and/or denser forests. The goshawk's morphological characteristics allow it to hunt efficiently in dense, mature forests. The MRNG, Siegel (1989), Patton (1975, 1984), Patton et al. (1985), Vahle and Patton (1983), and Goodwin and Hungerford (1979) all describe the abundant and/or diverse prey populations found in dense, mature forests. Therefore, the Department believes that managing for a relatively dense, mature forest structure provides the foraging habitat used by goshawks and abundant prey that can be efficiently captured.

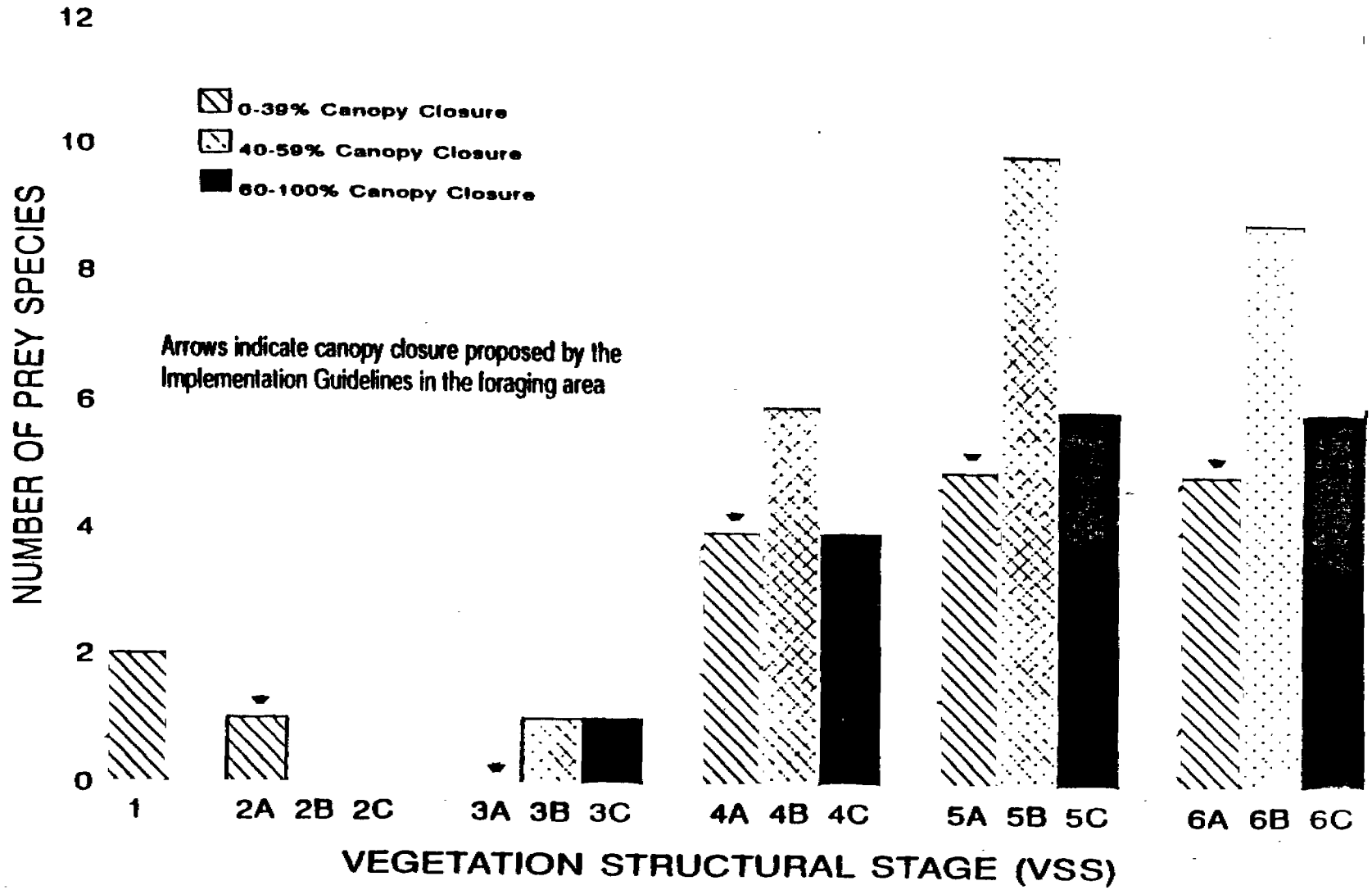

Figure 3. Vegetation Structural Stage (VSS) density classes that contribute to high populations of 14 summer prey species

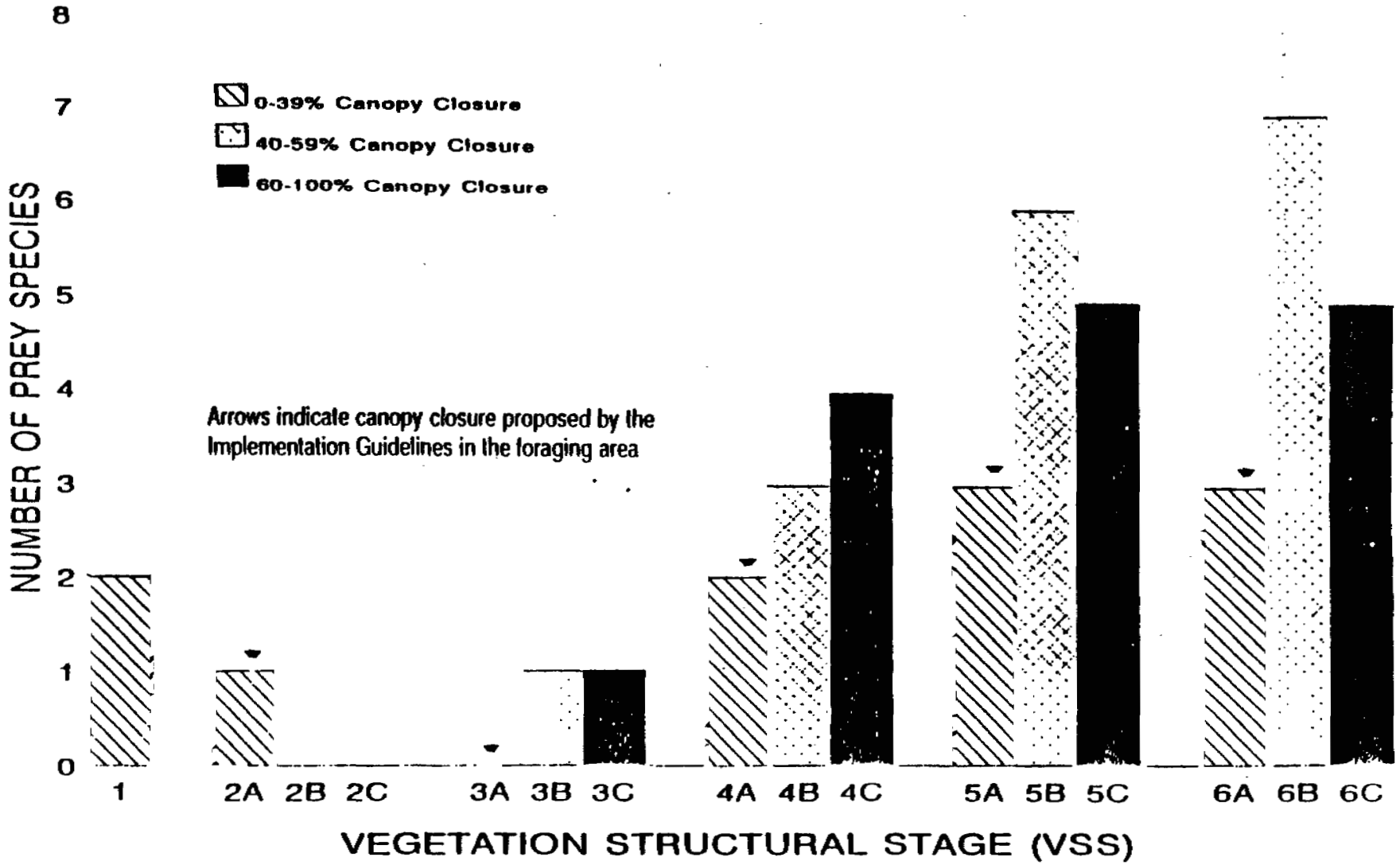

Figure 4. Vegetation Structural Stage (VSS) density classes that contribute to high populations of 8 winter prey species. From Reynolds et. al. 1992.

Another stated objective of the MRNG is to maintain a healthy mycorrhizal fungi community (Reynolds et al. 1992:31). The MRNG describes the importance of fungi as food for small mammals (including for several of the targeted prey species) and as a critical factor for tree nutrient absorption and regeneration.

[redacted]

The MRNG assumes that opening the forest will lead to increased

The Department has consistently coordinated with Forest Service

acknowledged. If the objective is to grow big trees quickly, they must not compete with each other. Hence, the model indicates the forest stand will need to be very open.

In order to demonstrate tradeoffs, the Department ran PROGNOSIS using a range of stand density index (SDI) levels (Appendix 5). SDI is most often described as a percentage of the maximum density that a given species of tree can reach. The wildlife equivalent is the idea of carrying capacity. A pond stocked with catfish can only carry a certain biomass of catfish without supplemental feeding. If the carrying capacity of the pond is 500 pounds, you can choose to have 500-one pound catfish or 100-five pound catfish, but not 150-five pound catfish. The nutrients limit what you can grow and simply won't support more than 500 pounds of catfish. SDI is the silvicultural counterpart of carrying capacity.

Maximum SDI represents an estimate of the maximum density of trees that can be grown on an acre. SDI is often described by both numbers and percentages. For ponderosa pine, maximum SDI (100% SDI) equates to the number 450 (Menasco and Higgins 1992, USDA Forest Service 1992c). Long (1985) gives three "key" SDI values which are important thresholds for timber management. The first key SDI value is 25% of maximum SDI, which equates to an SDI of 112. Long identifies this point as the onset of competition. Below this SDI, there is no competition between trees for available nutrients. Above this point, trees begin to compete slightly, but do not significantly inhibit each other's growth. The second key value is 35% of maximum SDI, which approximates an SDI of 160. This is the lower limit of full site occupancy. Above 160, all factors limiting stand growth (light, water, nutrients) are being used by the trees. Management below 160 results in a direct loss of potential wood production because the land has surplus nutrients which are not being used by the trees for growth. The third key value is 60% of maximum SDI, or an SDI of 270. Above this level some trees in the stand begin to die from competition.

Long (1985) suggested managing between 35% and 50% of maximum SDI where a relatively high priority is placed on maximization of timber volume production. For ponderosa pine, these percentages equal SDI 158 and 225, respectively. The Southwestern Region of the Forest Service's stocking chart for ponderosa pine (site index 70+) set the lower and upper management limits at SDI 110 and 348, respectively.

A series of PROGNOSIS runs modeled the effects of managing at different SDI levels in ponderosa pine stands. Four SDI levels were modeled using a site index of 70 and can be compared to the MRNG's Appendix 5 and the Implementation Guidelines' Appendix B. SDI levels of 90, 140, 160, and 220 were chosen to serve as bench marks and represent degrees of stand densities actually used or under consideration for forest management.

The PROGNOSIS model run using an SDI of 90 represents 20% of maximum density. This is the SDI level used in the Implementation Guidelines for the goshawk foraging area . According to PROGNOSIS, this SDI approximates 30% canopy cover; however, the Implementation Guidelines use it to represent the minimum canopy cover of 40% identified in the MRNG for management of goshawk foraging areas.

The PROGNOSIS model run using an SDI of 140 represents 31% of maximum density. PROGNOSIS shows an SDI of 140 provides the 40% canopy cover called for in the MRNG for the goshawk foraging area. The Southwestern Region of the Forest Service (1992c) sets a similar SDI level.

The PROGNOSIS model run using an SDI of 160 approximates 35% of maximum density and is the SDI which the Implementation Guidelines used to manage the goshawk PFAs. The Implementation Guidelines used SDI 160 to represent 60% canopy cover; however PROGNOSIS indicated this SDI produced a canopy cover closer to 45%.

The PROGNOSIS model run using an SDI of 220, 49% of maximum SDI, approaches 60% canopy cover. Again, the Southwestern Region (USDA Forest Service 1992c) uses a similar SDI value (212). Determining SDI levels equal to 40% and 60% canopy cover is important because these are forest management thresholds defined in the MRNG for different portions of the goshawk home range.

Results of SDI comparisons showed canopy cover, foliage biomass

Table 1. Effects of different SDI levels on several modeling factors using the timber growth and yield model, PROGNOSIS.

EFFECT OF CHANGING SDI ON PROGNOSIS MODELING RESULTS

MODELING FACTORS	STAND DENSITY INDEX 90	140	160	220
PERCENT CANOPY COVER AT 100 YRS.	27	39	44	58
PERCENT CANOPY COVER AT 200 YRS. [1]	30	41	45	57
PERCENT CANOPY COVER AT 250 YRS. [2]	32	44	48	60
FOLIAGE BIOMASS (LB/AC) AT 200 YRS.	3,764	4,539	4,852	5,381
FOLIAGE BIOMASS (LB/AC) AT 250 YRS.	3,624	4,544	4,834	4,929
QUADRATIC MEAN DIAMETER (INCHES) AT 200 YRS. [3]	30.5	26.9	26.2	22.7
QUADRATIC MEAN DIAMETER (INCHES) AT 250 YRS.	34.0	30.1	28.9	24.9
MERCHANTABLE VOL (BF/AC) AT 200 YRS.	15,386	21,772	24,979	28,295
MERCHANTABLE VOL (BF/AC) AT 250 YRS.	15,774	23,034	25,269	30,270
TOTAL VOLUME (BF/AC) FOR 200 YRS.[4]	28,686	33,711	36,433	39,446
TOTAL VOLUME (BF/AC) TO 250 YRS.	32,439	38,610	42,042	45,104

[1] Implementation Guidelines use a 200 year rotation in the goshawk foraging area.
[2] Rotation age proposed by Arizona Game and Fish Department (see Recommendations section).
[3] Quadratic mean diameter equals the DBH of the tree of average basal area in a given stand (Smith 1986).
[4] Total volume is thinning volume plus all merchantable volume through the end of the rotation.

It is difficult to understand why the Forest Service has chosen such a low SDI level for management of the goshawk foraging area. Not only does this prescription fail to achieve even the minimum canopy cover called for by the MRNG (40% for VSS 4-6 in ponderosa pine foraging areas) but, it yields less timber volume over time.

The Department recommends that the goshawk foraging area be managed for a higher average canopy cover with a wide range of forest densities around that average. Specific recommendations are provided at the end of this document (see Arizona Game and Fish Department Recommendations).

Snag Recruitment and Longevity Modeling

The importance of snags (standing dead trees) to the forest ecosystem has been well documented. For instance, snags are utilized by 85 species of North American birds (Scott et al. 1977), a minimum of 49 species of mammals, as well as some species of

Results of Snag Recruitment Modeling

Under the "intensive management" scenario, the model projected an average of 1.1 - 1.2 snags per acre would be maintained in the foraging area (Fig. 5). The "minimal management" scenario would only maintain about 1.6 - 1.7 snags per acre. Given the assumptions discussed above, the model projected that a rotation length of at least 250 years was needed to maintain two snags per acre. Therefore, based on model projections, none of the management options offered in the MRNG will meet the MRNGs stated DFC of two snags per acre. The objective of two snags per acre is biologically appropriate, but proposed management strategies cannot accomplish the objective.

The Department's modeling process gave the benefit of the doubt to the MRNG and Implementation Guidelines by 1) setting the recruitment tree mortality at 5%, 2) assuming mortality increased at 150 years of age, and 3) assuming that 25% of the snags remained standing for a maximum of 50 years (unlikely where snags are cut for fuelwood). Therefore, it is likely that the Department's model outputs overestimated the number of snags per acre which will be produced and retained. According to the Department's model, the management scenario cited in the Implementation Guidelines for the goshawk foraging area produced approximately half the desired number of snags.

Therefore, the current goshawk management strategy cannot meet its objective of two snags per acre. To accomplish the MRNG snag objective, at least 12 old trees per acre will have to be left as reserve trees (Fig. 6). Three management changes that can increase snag densities include 1) increase rotation lengths so more of the VSS 5 and 6 trees can become snags, 2) manage for a higher density of VSS 5 and 6 trees per acre so more of those trees can become snags, and 3) leave more reserve trees per acre at the time stands

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The Department suggests that all three changes be incorporated. Specific recommendations are provided at the end of this document (see Arizona Game and Fish Department Recommendations).

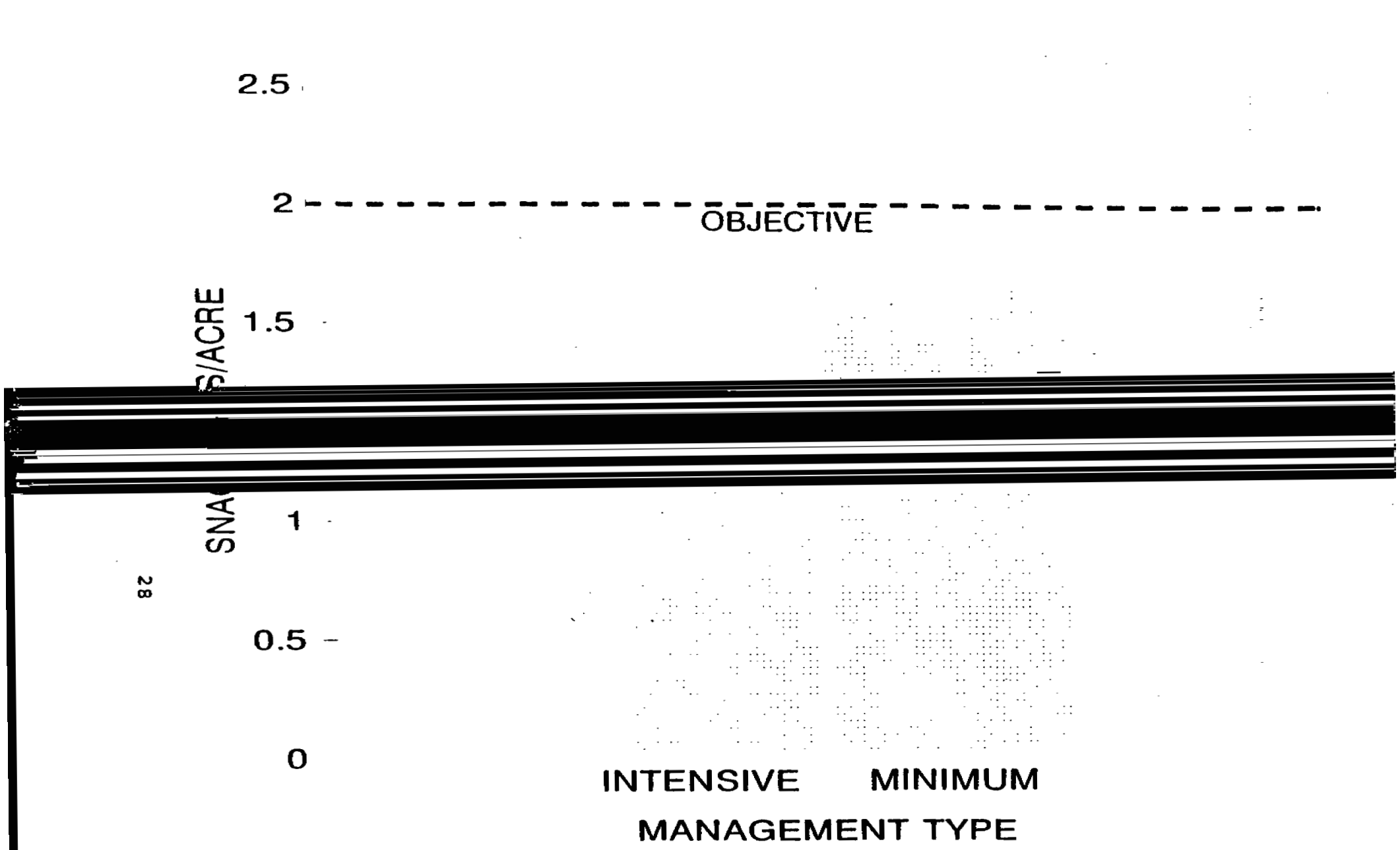


Figure 5. Comparison of snags produced under two Forest Service Management scenarios. "Intensive" management approximates a 190 year rotation. "Minimum" management approximates a 230 year rotation. Both scenarios assume a 5% mortality/decade. From the Arizona Game and Fish Department's Snag Recruitment Model, 1992. See Appendix 6.

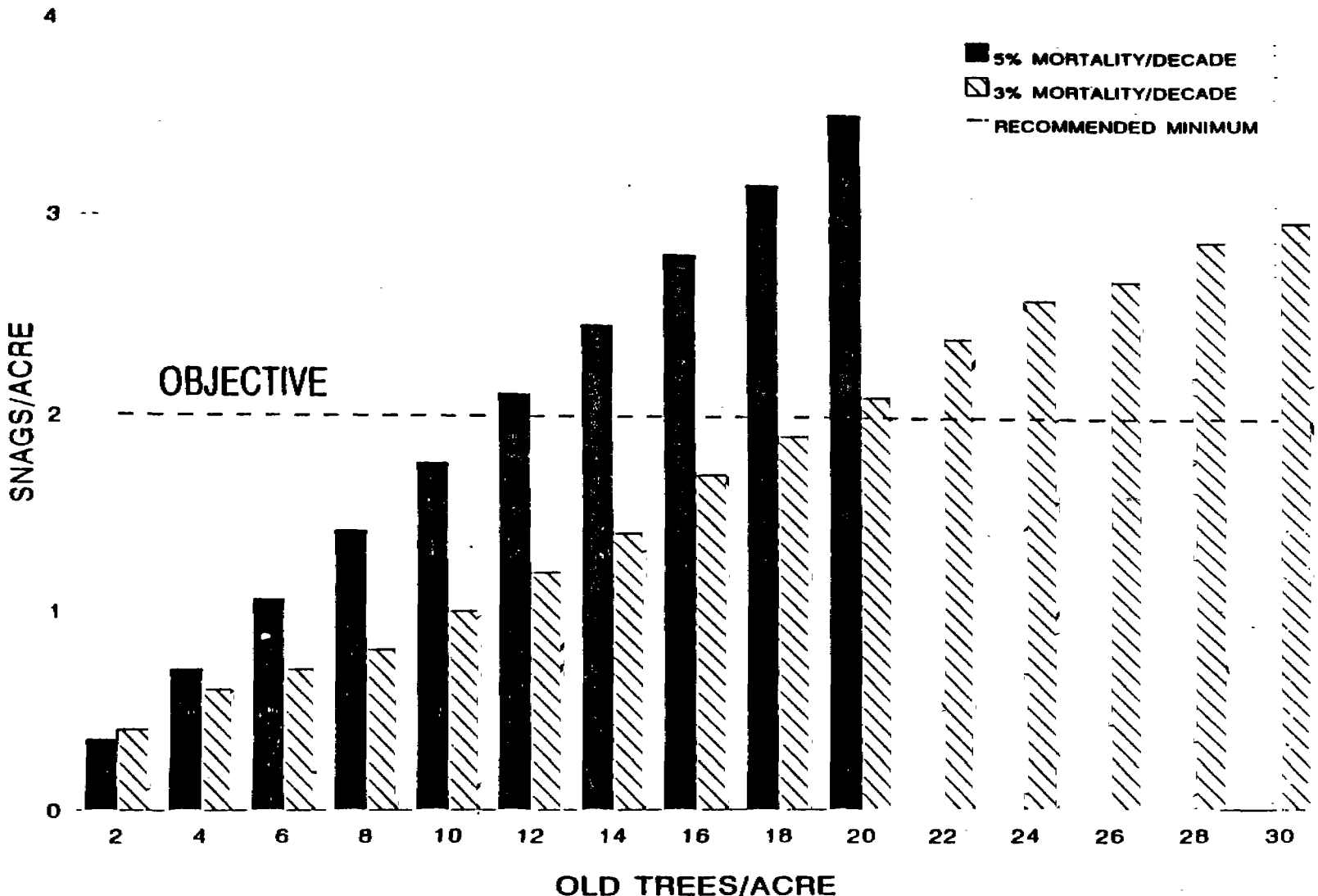
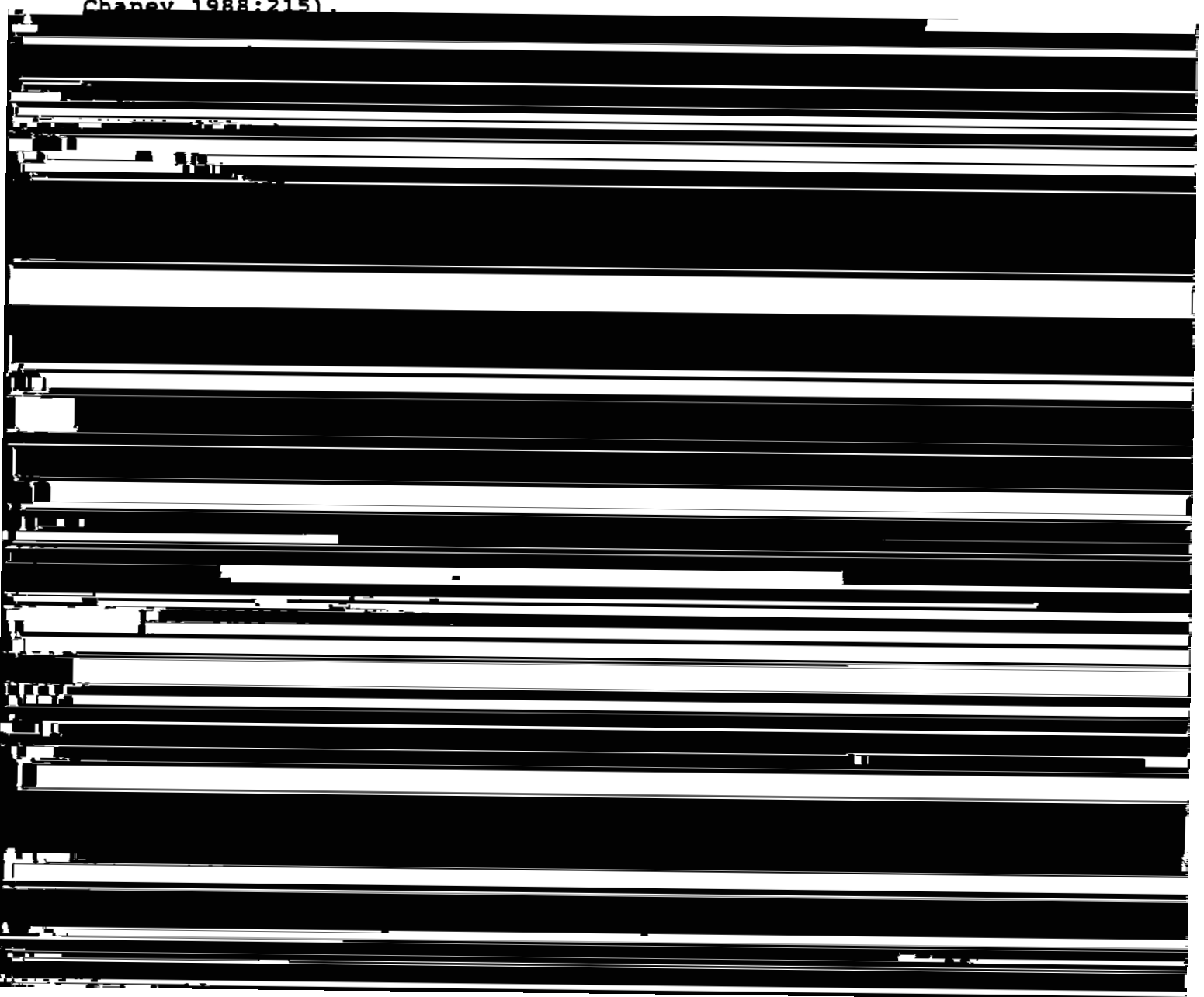


Figure 6. Comparison of the number of old trees per acre needed to provide two snags per acre at different tree mortality rates. From the Arizona Game and Fish Department's Snag Recruitment Model, 1992. See Appendix 6.

Management of Goshawk Nest Stands and Post-fledging Family Areas

The Department has two related concerns regarding management of nest areas and PFAs. First, there should be no structural difference between nest areas and PFAs. Second, the MRNG and Implementation Guidelines do not provide for additional PFAs to allow the current goshawk population to maintain itself and to expand into unoccupied habitat.

Structural Difference. The MRNG recognized that goshawk nest stands were characterized by "relatively high tree canopy cover and a high density of large trees..."(Reynolds et al. 1992:13). Several studies (Hennessy 1978, Reynolds et al. 1982, Hall 1984) found that goshawks selected nest stands more dense than the surrounding area. Crocker-Bedford and Chaney (1988) found that goshawks nested in the densest stands available on the North Kaibab Ranger District. Goshawks did not nest in stands with less than 60% canopy cover and preferred stands with over 80% canopy cover (Crocker-Bedford and Chaney 1988:213). Minimum canopy cover levels in goshawk nesting habitat were: 79% in good habitat, 72% in suitable habitat, and 60% in marginal habitat (Crocker-Bedford and Chaney 1988:215).



600 acre blocks are managed as foraging habitat (as has been proposed on the North Kaibab), there will be no 600 acre blocks of unoccupied suitable habitat remaining where new goshawk pairs can nest. Neither the MRNG nor the Implementation Guidelines provide for the recruitment of additional blocks with high quality nesting habitat. As some of the known PFAs are lost to fire or other causes, the goshawk population would be expected to decline. The Department addresses this concern in the recommendations at the end of this document (see Arizona Game and Fish Department Recommendations).

Management of Lands Designated as Old Growth or Unsuitable

Forest managers have expressed interest in applying MRNG prescriptions to areas allocated as old growth and areas designated as "unsuitable" for timber production in Land Management Plans under the provisions of the National Forest Management Act. The impetus for this has been 1) the "landscape ecology approach" proposed by the GSC (Reynolds et al 1992:8), and 2) concerns for forest health (Reynolds et al 1992:79). It has also been stated that implementation of the MRNG will render old growth, snag recruitment, migration corridors, hiding and thermal cover, and other wildlife habitat attributes less meaningful, or of less concern (Menasco and Higgins 1992:6). The implications of this statement and application of the MRNG on acres set aside as old growth or unsuitable for timber production are of serious concern to the Department.

Areas currently exempt from intensive timber management are important habitats for many wildlife species as indicated in the MRNG (Reynolds et al 1992:5, 30, 31). These areas have habitat characteristics that are rare outside of these protected areas (e.g., more snags, larger blocks of habitat, larger trees, critical transitional habitat from summer range to winter range). Old growth and "unsuitable" acres make a valuable contribution to the variation in forest conditions which enhances wildlife diversity.

Old growth habitat attributes are important to a number of Southwestern wildlife species, including snag dependent birds (see "Cavity-Dependent Birds" section under "Issues Requiring Further Consideration), as well as other species of nongame birds (Siegel 1989). Old growth habitats may also be important to other species, such as bats, whose habitat requirements are poorly understood.

The Mexican spotted owl, a subspecies which has recently been listed as Threatened under the Endangered Species Act (USDI Fish and Wildlife Service 1993), shows a preference for habitat characteristics associated with old growth and unsuitable areas, such as steep slopes. Fragmentation of potential and existing spotted owl habitat and habitat loss due to timber harvest were

The Department supports forest management practices that retain or attempt to develop old growth forest attributes, such as snags, large trees, and downed woody materials. The MRNG seeks to create and maintain forest conditions associated with old growth (Reynolds et al. 1992:30-31). However, the ability of the management strategy to achieve and sustain these conditions is unknown. Equally uncertain is the degree to which management can mimic "naturally-developed" old growth. A recent review by Thomas et al. (1988) supports this position, proposing that old growth habitat management be based on existing stands, rather than those created by silvicultural practices.

The Society of American Foresters (1984) and The Wildlife Society (1992) have both taken positions advocating retention of existing old growth. The Society of American Foresters' (SAF) position statement begins:

> "...the best way to manage for old growth is to conserve an adequate supply of present stands and leave them alone" (SAF 1984:17).

The SAF (1984:31) later elaborated to say:

> "Through silviculture, foresters can grow big trees and grow them faster than nature unassisted. Yet there is no evidence that old-growth conditions can be reproduced silviculturally. In fact, the question is essentially

The "Position Statement on National Forest Old-Growth Values" developed by the Forest Service (USDA Forest Service 1989) states that attention should be given to minimizing fragmentation of old growth into small isolated areas and that where appropriate, land management decisions are to maintain future options. Therefore, proposals to silviculturally treat old growth areas contradict the positions advocated by both professional biologists and forest managers.

As defined by the National Forest Management Act, areas classified as unsuitable are protected from reclassification for ten years. The intent of the Act, as defined in the Congressional debate surrounding the definition of unsuitable lands, was to remove from standard forestry practices those lands which were marginally productive or fragile (CEQ 1972). The inclusion of these areas in lands considered for intensive management under the MRNG would violate the intent of Congress. There are provisions in the Act for harvest on unsuitable lands to benefit wildlife. However, in light of the disagreement and doubts presented in this document about the wildlife benefits claimed from implementing the MRNG on suitable timber lands, even more caution should be used on unsuitable lands. Finally, much of the landscape-scale diversity which the MRNG is trying to develop, using silvicultural prescriptions, already exists on unsuitable lands due to their typical location on the boundaries between vegetation types.

Both old growth and "unsuitable" areas play an important role in research and monitoring. In the Pacific Northwest, information derived from unmanaged areas is being used to develop strategies for conserving biodiversity in managed forests (Hansen et al. 1991). This approach is equally relevant to Southwestern forests. Current and future research by the Department and others will provide needed information on the importance (or lack thereof) of old-growth habitats to goshawks, nongame birds, and other wildlife species. Areas not subjected to intensive management will also serve as controls with which to evaluate the effects of the MRNG and other new management prescriptions.

The Department supports the ecosystem management concept. However, the MRNG represents a new and untested approach, which is not yet ready to be applied on a landscape scale. The Department's concerns regarding landscape application of this untested approach are discussed in greater detail later in this document (in the section entitled "Wildlife Science and Its Application to the Management Strategy").

For the reasons described above (and elsewhere in this document)

Managing For Minimums

The Forest Land Management Plans described most wildlife Standards and Guidelines (old growth, snags, wildlife cover) in terms of minimum thresholds to accomplish biological objectives. During the planning of timber sales, these minimums have consistently become maximums. Also, many acres allocated to meet the Standards and Guidelines in the Forest Plans do not have the forest attributes needed to fulfill the biological objectives (USDA Forest Service 1990). Therefore, wildlife habitat thresholds are further compromised. This same pattern has occurred with the development of the Forest Service goshawk management strategy.

Since publication of the MRNG, the Implementation Guidelines and proposed alternatives in upcoming timber sales have redefined or reinterpreted minimum thresholds set in the MRNG. These adjustments have moved toward a more open canopy and younger-aged forest. Examples of these adjustments or targeting of minimums are described below for canopy cover, rotation length and number of reserve trees.

Canopy Cover. The MRNG calls for managing goshawk foraging areas so that VSS 4, 5 and 6 comprise 60% of the area, with approximately 20% in each VSS class. The remaining 40% is to be comprised of VSS 1-3. The foraging area guidelines in the MRNG stated that all of the acres in VSS 4-6 should be managed for a minimum 40% canopy cover. This would include the "B" (40 to 59% canopy cover) and "C" (60+ % canopy cover) canopy cover classes. The "A" canopy cover class (0-39% canopy cover) did not contribute to the acreage objectives for VSS 4-6.

In the Implementation Guidelines, Menasco and Higgins (1992) redefined the break between the "A" and "B" canopy cover classes based on their desire to produce forage, rather than providing the canopy cover called for in the MRNG. The Implementation Guidelines set the A/B break at 90 SDI which, according to the Forest Service PROGNOSIS computer model, would approximate only 30% canopy cover. The Southwestern Region of the Forest Service (USDA Forest Service 1992c) and the PROGNOSIS model show that 40% canopy cover approximates an SDI of 140. Therefore, application of the Implementation Guidelines creates an on-the-ground condition that does not provide the minimum 40% canopy cover recommended in the

cover level in 10 years. This alternative, and others, have treated the minimum canopy cover level in the MRNG as a maximum target, not to be exceeded. As described above, application of the Implementation Guidelines results in about 30% canopy cover in the foraging area. Proposed management, which decreases canopy cover below the level called for in the Implementation Guidelines, may result in canopy cover near 25% over 5400 acres of each 6000 acre goshawk area.

As discussed earlier, Smith and Mannan (in review), Austin (1991) and others identified goshawk preference for areas with higher canopy cover. The Department considers the open forest conditions being proposed for timber sales, and justified by the Implementation Guidelines, harmful to the goshawk and many other wildlife species (examples will be discussed in later sections). As previously shown in Figures 3 and 4, many prey species expected to support goshawks benefit more from the "B" and "C" canopy classes than from the "A" class called for in the Implementation Guidelines. Also shown earlier in Table 1, management at higher SDIs (and canopy cover) produces more timber volume. If the management objective is to benefit goshawks and their prey, it is difficult to understand why the Forest Service has advocated such low canopy cover levels.

Rotation Age. In another example of managing for the minimum, the Implementation Guidelines assumed a 20 year re-entry period (the period between timber harvests on an area), with 10% regeneration (or VSS 1) at each re-entry. This results in a 200 year rotation. The MRNG gives 200-250 years for ponderosa pine to reach mid-aged VSS 6 in the foraging area and PFA. Therefore, rotation lengths should be at least this long. However, the Proposed Action for the Paris/Stina and Holy Hollow Timber Sales on the North Kaibab Ranger District, proposed 15% regeneration. With a 20 year re-entry period, 15% regeneration would result in a 140 year rotation. On the same sales, alternatives were considered which proposed 20% regeneration, the equivalent of a 100 year rotation. Since it takes 140-170 years for a ponderosa pine to develop the bark and limb characteristics of a mature tree, these shorter rotations clearly do not produce the wildlife benefits associated with mature and overmature trees. According to the MRNG (Reynolds et al. 1992:19), these mature and old growth structural stages (VSS 5 and 6) support more goshawk prey than any other stages. Thus, it is again very difficult to understand how shortening the rotation age will have any benefit to goshawks or their prey.

proposed alternatives on the Paris/Stina and Holy Hollow Timber Sales call for 3 reserve trees per acre. The Department believes that managing for the minimum number of reserve trees will harm many species of wildlife and their habitat (see "Cavity-dependent Birds" in section entitled "Issues Requiring Further Consideration").

ISSUES REQUIRING FURTHER CONSIDERATION

Summary of Habitat Component Deficiencies

The Department is concerned with the potential impacts of implementing the MRNG on all forest-dwelling species. Therefore, the Department's evaluation of the Forest Service management strategy goes beyond the goshawk and the 14 prey species identified in the MRNG to include the potential impacts on habitat components required by a broader range of forest wildlife. The Department

Table 2. Mean DBH of snags used for nests by birds of the Southwest.

Species	Diameter at Breast Height (inches)	Source*
Violet-green swallow	30	A
Pygmy nuthatch	27	A
	18	B
	15	C
Western bluebird	27	A
Mountain chickadee	25	A
Brown creeper	34	A
	27	B
Red-breasted nuthatch	28	B
Hairy woodpecker	17	B
Norther flicker	24	B
Lewis woodpecker	27	B
Williamson's sapsucker	32	B

*A = Cunningham et al 1980
B = Raphael and White 1984
C = Hay and Guntert 1983

There are several reasons why large snags are beneficial to cavity-using species. Clutch size of passerines has been shown to increase with cavity size (Karlsson and Nilsson 1977), and larger snags tend to provide larger cavities. There is greater insulation in larger snags. Presumably, nestlings in larger snags fledge earlier and thus have more time to put on weight to survive the following winter. O'Conner (1978) found that great tits nested earlier in better insulated, warmer nest boxes than in cooler, less insulated nest boxes. Some evidence also exists that large snags may be important as a foraging substrate (Cunningham et al. 1980, Raphael and White 1984, USDA Forest Service 1985). Furthermore, large snags last longer than small snags (Keen 1955, Bull 1983), and this is an important consideration when determining how many snags will be needed over time.

Raphael and White (1984) showed that snags >15 inches DBH were

Miller and Miller (1980:337) studied snag use by birds and stated:

> "Size of nest trees, characteristics of decay and availability of suitable trees all affect cavity nesters. Dead and partly dead trees are important in many other ways. They are used for foraging, drumming, singing posts, food caching, nesting on, nesting under bark, hunting perches, loafing, lookouts, anvils, plucking posts, landing and roosting. Dead, dying, deformed and down trees play a vital role in a complex system."

Other research has also demonstrated the need for and importance of

nester, associated with mature and old growth ponderosa pine habitat types as well as ponderosa pine-oak habitat types (Howie and Ritcey 1987; Reynolds and Linkhart 1987, 1992; Reynolds et al. 1989; Johnson and Zwank 1990). The owls are known to nest in cavities in live trees and in snags.

In British Columbia, Howie and Ritcey (1987) found flammulated owls in forest structures with a canopy cover ranging from 35-65%. At least two canopy layers were present, with older firs and pines forming the upper layer and young firs forming the lower layer. A poorly developed shrub layer, but a well developed herbaceous layer

Mexican Spotted Owl

The Mexican spotted owl subspecies was recently listed as Threatened under the Endangered Species Act (USDI Fish and Wildlife Service 1993). The Mexican Spotted Owl Status Review (Mcdonald et al. 1991) found high tree density, high canopy cover and multi-storied stands to be among the common characteristics of spotted owl habitats across different forest types. Neither of these conditions is compatible with the MRNG. Foraging spotted owls used unlogged habitats more than expected, assuming movements were random, and logged habitats less than expected. Owl use areas had higher basal areas and more snags and downed logs than randomly selected sites (McDonald et al. 1991). The open forest to be created under the Forest Service management strategy will not favor conditions selected by the Mexican spotted owl.

Sharp-shinned Hawk

The sharp-shinned hawk (*Accipiter striatus*) is another Forest Service sensitive species (USDA Forest Service 1989a). The hawk nests in dense stands composed of mixed conifer or young ponderosa pine (VSS 3). Reynolds (1983) noted that nest sites were located in young conifer stands (25-50 years old) and had high canopy cover and tree density. High tree density created stands with shallow crowns and many dead limbs on the boles below the crowns. Sharp-shinned hawks are the most agile of the forest raptors and are also known to forage in dense vegetation, VSS 3 and 4 stands (Jones 1979).

Reynolds (1983) recommended that nest sites not be isolated by silvicultural treatments. Reynolds (1983) also suggested that precommercial and commercial thinning decrease nesting habitat for sharp-shinned hawks since these practices result in reduced tree

Merriam's Turkey

Radio telemetry studies of habitat use by Merriam's turkey (*Meleagris gallopavo merriami*) in the western United States have documented that different habitat characteristics are selected for various behavioral activities. The general characteristics of nesting (Petersen and Richardson 1975, Goerndt 1983, Schemnitz et al. 1985, Hengel 1990, Leidlich et al. 1991, Mollohan and Patton 1991, Wakeling 1991), brooding (Mackey 1982, Goerndt 1983, Green 1990, Rumble 1990, Mollohan and Patton 1991), roosting (Hoffman 1968; Boeker and Scott 1969; Phillips 1980, 1982; Jones 1981; Goerndt 1983; Hengel 1990; Mollohan and Patton 1991; Wakeling, unpubl. data), and winter habitat (Wakeling, unpubl. data) are presented in the following sections.

Nesting habitat. On the Kaibab National Forest, in north-central Arizona, nest sites typically had more ground cover at the nest than in surrounding areas (Crites 1988). Seventy-five percent of the nests occurred in a combination of conifer, oak thickets, and slash, with half of the nests being located at the base of a tree on the uphill side. Successful nests had significantly more cover at the nest site than did unsuccessful nests, and significantly more slash and dead and down wood.

In mixed conifer forests in the Sacramento Mountains of New Mexico, nests occurred on steep slopes even though more level topography was readily available (Jones 1981, Goerndt 1983, Schemnitz et al. 1985). Overstory canopy cover at nest sites was higher than that of the surrounding area and percent ground cover was high. Cover at the nest site was provided by slash, shrubs, downed logs, or contour effects.

The above literature indicates that when managing for turkey nesting habitat, at least 20% of the stand should be made up of 0.1-2 acre patches of cover with 30-60% ground cover at 0-3 feet of height, made up primarily of large (>12 inches DBH) downed logs and scattered or loosely piled slash, deciduous and conifer regeneration, and herbaceous vegetation. Sites should be multi-storied with >50% overstory cover, the first story ≤10 feet above ground level. The distance to the point where another human being is obscured from vision (human sight distance) should average <75 feet. Stands are generally uneven-aged with the predominant size class 4-12 inches DBH. Under and overstory distributions are generally clumped. Deciduous regeneration is usually abundant. Sites are generally located within 0.5 miles of water and 0.5 miles of acceptable brood habitat.

Brood habitat. Brood habitat typically consists of mesic stands in association with a drainage or canyon, including headers and draws. This habitat is generally a landscape mosaic of varied stand characteristics. Stands should have a clumped distribution. Stands with overall basal areas of 90-120 feet^2/acre and human sight distances <150 feet are preferred. Small openings (0.5-2 acre)

within dense stands (140 feet^2/acre basal area) of VSS 3 with large (>12 inches DBH) downed logs scattered throughout appear to provide excellent brood habitat. Herbaceous cover tends to be high in the openings (>50% ground cover and 10 inches tall) and low within dense stands (<20% ground cover). Approximately 20-50% of the stand should provide feeding habitat and 20-50% should provide loafing and escape habitat.

Roosting habitat. Boeker and Scott (1969) found that roosts on the Fort Apache Indian Reservation were typically groups of large, overmature ponderosa pines with flat horizontal branches. Roost sites usually occurred on ridgetops or canyon walls with easy access from above and a forest opening below. Roost sites on the Bill Williams Mountain study area (Phillips 1982) averaged 27 usable roost trees per site and had an average basal area of 94 feet^2/acre. A typical roost tree was a large (usually >20 inches DBH), dominant or codominant ponderosa pine with flat horizontal branches.

Stands used for roosting tend to be distinct clumps of ponderosa pine trees situated on the upper edges of canyons and drainages. The minimum DBH for usable roost trees is 16 inches, and an average

existing turkey habitat. The following discussion identifies some of the potential favorable and unfavorable impacts of implementing the MRNG on turkeys.

Favorable effects of the MRNG. The management of forest stands and openings on a small scale (≤4 acre) should favor Merriam's turkeys. Throughout the literature, small clumpy stands were identified as those selected by turkeys. The suggested recommendations for lopping and scattering 3-15 tons per acre of slash is consistent with the recommendations for turkey habitat in Arizona (Mollohan and Patton 1991, Wakeling 1991). Group selection harvests have been recommended by Mollohan and Patton (1991) and Wakeling (1991) as a suitable harvest strategy that has favored turkeys in the past. In some instances, Reynolds et al. (1992:25) also favor this treatment for the goshawk. The long-term maintenance of snags and the resulting longevity of downed logs (>12 inches DBH and 8 feet in length) would favor turkey loafing and hiding cover.

Unfavorable effects of the MRNG. The MRNG employs a management strategy based on Vegetation Structural Stages that does not reflect turkey habitat selection (Mollohan and Patton 1991) and therefore is not readily comparable to turkey habitat needs. In the goshawk foraging area, the MRNG and the Implementation Guidelines manage against multi-storied stands, dense understories and dense canopy which are forest attributes selected by turkeys in most habitats (Mollohan and Patton 1991, Wakeling 1991). An underlying management objective of the MRNG in calling for relatively open understories is to increase the goshawk's opportunity for detection and capture of prey. Turkeys are prey to many predators and opening the understory may increase turkey mortality rates.

Conclusions. Turkeys select habitats that tend to have a large degree of interspersion and landscape mosaics which the MRNG promotes. However, turkeys select multi-storied stands and areas of low horizontal visibility created by a clumpy understory, forest characteristics that the MRNG and Implementation Guidelines manage against. Opening the understory and reducing the amount of available horizontal cover would reduce the quality of turkey habitat until such time as adequate cover could regenerate. Thus, the implementation of the MRNG on a landscape basis would reduce the suitability of many acres across national forests throughout the state for Merriam's turkeys.

Cottontail

The cottontail (*Sylvilagus* spp.) has been studied for decades across the United States. The common thread throughout the literature is the species' need for cover.

Todd (1927) stated that protection from predators was as important

forsake an abundant food supply for good cover if the two were not found together. Ingles (1941) said the cottontail is very dependent on cover for protection and nest sites. Trippensee (1934) found that as cover became scarce and more open in the fall and winter, cottontails moved to denser vegetation. Bell (1948) observed that cottontails seldom moved more than 30 feet from protective cover when feeding.

In a review of cottontail feeding habits, DeCalesta (1971) noted that the cottontail is ubiquitous, eats a wide variety of foods, cover may be more important to this species than specific foods, and that lack of food does not appear to be an important winter mortality factor. Based on this review of feeding habits, DeCalesta (1971) suggested that management of the species may not require detailed quantitative or qualitative analyses of foods eaten. Kundaeli and Reynolds (1972) studied cottontail use of natural and modified pinon-juniper in New Mexico. They found that cottontail densities were significantly lower on treated areas where all trees were removed (despite more than a doubling of herbaceous vegetation) than on the control. Within the range studied (150-370 lbs/acre), herbaceous vegetation biomass did not seem to affect cottontail habitat use. Turkowski (1975) stated that in most parts of its range, cottontail survival and reproduction are limited more by factors such as the availability of moisture and cover and not by food abundance. In recommending habitat management for cottontails, the Soil Conservation Service (USDA Soil Conservation Service 1978) stated that the most important component of rabbit habitat is cover, and that mature forests with clean understories are generally not good rabbit habitat.

The studies cited above come from across the country and reflect the general body of knowledge on cottontail habitat needs. Costa (1976) studied habitat use by cottontails in different ponderosa pine forest structures on the Coconino and Apache-Sitgreaves National Forests. On the Beaver Creek Study Area, Costa (1976) found that cottontail densities were not affected by strip cuts, shelterwood cuts, patch cuts, or group selection harvesting. This is significant because similar methods are being used to implement the MRNG with the expectation of increasing rabbit densities. Only

vs 642), about 4 1/2 feet tall, than the rest of Watershed 1. Costa (1976) concluded that the positive responses of cottontails on Beaver Creek Watershed 12 and on Heber Watershed 1 could be attributed to the increase in yearlong cover and that the absence of sufficient cover in a typically open ponderosa pine forest is the limiting factor.

The MRNG includes the cottontail as one of 14 goshawk prey species. The MRNG acknowledges the value of cover for cottontails (Reynolds et al. 1992:60-62) but then erroneously defines openings and open forest conditions (Reynolds et al. 1992:19) as important for this species. Furthermore, the MRNG's recommendation to increase grasses, forbs, and shrubs in ponderosa pine is problematic. While grasses and forbs will increase as the pine canopy is opened, it's unlikely they will reach densities sufficient to provide hiding cover for cottontails. Similarly, shrubs found on pine sites (*Ceanothus, Ribes, Cercocarpus, Rosa, Rhus*, etc.) do not normally grow in densities adequate to produce hiding cover. Plants that could provide hiding cover (oak, aspen, locust, fir, pine) will not be managed for cover because of the MRNG's objective to maintain an open understory.

Tree Squirrels

Both species of tree squirrels (tassel-eared squirrel, *Sciurus aberti*, and red squirrel, *Tamiasciurus hudsonicus*) are listed as goshawk prey in the MRNG. The MRNG was evaluated to determine its capability to maintain tree squirrel habitat quality and sustain healthy tree squirrel populations to meet the goshawk's foraging needs. Several concerns were identified and are addressed in the following discussions.

Overall, the VSS distributions prescribed in the MRNG for all forest types (i.e., ponderosa pine, mixed species, and spruce-fir) should favor habitat conditions for both squirrel species. However, the desired canopy cover levels (i.e., minimum of 40%) and small patch sizes (i.e., 4 acres or less) which would be created over time, over large areas (e.g., foraging areas), are not likely to provide sufficient quality habitat to sustain healthy squirrel populations.

Canopy Cover Concerns. The purpose of the 5,400 acre foraging area, which constitutes 90% of the goshawk territory, is to provide quality habitat for goshawk prey species and to promote desired forest conditions that would provide abundant and sustainable prey populations (Reynolds et al. 1992). Habitat information for both tree squirrel species, from studies conducted in Arizona (Patton 1975 and 1984, Patton and Vahle 1986, Vahle and Patton 1983), was summarized in the MRNG. This information stresses the importance of providing habitat conditions exceeding 60% canopy cover (i.e., through prescribed levels of tree density and basal area). These habitat needs, however, are not fully integrated in the management prescriptions for the foraging area, particularly for the tassel-

eared squirrel. The open stand conditions that are prescribed for ponderosa pine foraging areas, and in some cases mixed species foraging areas, will limit the capability to maintain and develop interlocking canopies that are necessary for good quality habitat for tassel-eared and red squirrels (D.R. Patton and B. Vahle, pers. commun.) over potentially large landscape areas.

Mycorrhizal fungi (e.g., truffles) provide an important food source for both tassel-eared and red squirrels, as well as other mammalian goshawk prey species (e.g., chipmunks, ground squirrels). Furthermore, the fungi function in a critical symbiotic relationship with conifer trees and small mammals in maintaining forest regeneration and forest ecosystem health (States 1985). As summarized in the MRNG (Reynolds et al. 1992), fungi are best produced in conifer stands which exceed 60% canopy cover (States 1985, States et al. 1988, Uphoff 1990). However, healthy fungi populations and tree squirrel habitat will be difficult to maintain in foraging areas, where canopy cover levels will rarely exceed 40% (J.S. States, pers. commun.). Consequently, the availability of fungi to support "abundant" prey populations, such as tree squirrels and other small mammals (e.g., chipmunks, ground squirrels), may be inadequate in goshawk foraging areas.

The DFC for goshawk foraging areas, discussed in the Implementation Guidelines, also raises concern about maintaining and developing quality tree squirrel habitat. This concern is particularly relevant to maintenance of tassel-eared squirrel habitat. As stated previously, the intent of the MRNG in foraging areas was to provide quality habitat for prey species and forest conditions that would provide abundant and sustainable prey populations. The prescribed tree densities and basal areas for VSS 4-6 in pine foraging areas, however, would only provide "poor" habitat (sensu Patton 1984). If the tassel-eared squirrel is an important prey species for the goshawk during the critical winter period, habitat quality for this species needs to be maintained to meet the goshawk's winter foraging needs. This concern is magnified when considering application of the MRNG across the landscape, "...in all our forested ecosystems with minor modifications to fit all species" (Menasco and Higgins 1992:7). Habitat capability for the tassel-eared and red squirrels, as well as cover needs for other species, could be adversely affected if the MRNG and Implementation Guidelines are applied across large landscape areas without significant modification (D.R. Patton, pers. commun.).

Patch/Stand Size Concerns. The key to accommodating habitat needs of a variety of forest dwelling species, which may have varying home range sizes, such as tree squirrels, is to provide a diverse arrangement of habitat structural stages and patch/stand sizes (e.g., 1-100 acres or more) (Patton 1992). For example, small habitat patches (e.g., <5 acres) may be important for species of low to moderate mobility which need "edge" habitats to meet their food and cover requirements (Patton 1992). In contrast, some species such as Northern spotted owls, requiring larger patch/stand

special conditions provided by "interior" forest stands (Galli et al. 1976). In the Pacific Northwest, minimum stand sizes to maintain maximum bird species diversity, have been estimated at 75-100 acres (Galli et al. 1976, Thomas et al. 1979). There is concern that the current prescriptions in the MRNG will not provide an adequate mosaic of patch size and structure for tassel-eared and red squirrels, as well as other wildlife species, particularly in foraging areas.

As forest stands are reduced in size so that openings and stands become the same size, homogeneity rather than diversity is maximized (Patton 1992). Conforming to a fixed or narrow range of stand sizes will not provide the diversity that is needed to maintain habitat for a large number of wildlife species. Landscape diversity is greatest with a variety of stand sizes ranging from large to small within a management area (Patton 1992). Over time, implementation of the MRNG would fragment forest habitats into patches/stands of 4 acres or less across large landscape areas. On a small scale, these treatments could increase the habitat mosaic and diversity. However, the relative uniformity of the prescribed treatments across large areas and the lack of large patches would ultimately reduce habitat capability for the tassel-eared squirrel, red squirrel and other species, and could reduce overall biological diversity (D.R. Patton and B. Vahle, pers. commun.). Tassel-eared squirrels, for example, need large stands (range = 30-100 acres, average = 50 acres) of relatively similar and contiguous forest in VSS 4-6 to meet many of their food and cover requirements (D.R. Patton, pers. commun).

Historical accounts of "presettlement conditions" describe a wide variety of tree densities and patch/stand sizes across forested lands in Arizona (Beale 1858, Bourke 1874, Dutton 1882, Leiberg 1904, Cooper 1960). Historically, this variability was created and maintained by the occurrence of frequent fires and by insects and disease. It is highly unlikely that historic fires, or other factors affecting stand structure and composition, would have developed a relatively homogenous distribution of small habitat patches of similar size across the landscape, as prescribed in the MRNG (D.R. Patton, pers. commun.).

Finally, both the tassel-eared and red squirrel may be important to goshawks during the winter because they are active during this season and available as prey within ponderosa pine, mixed species, and spruce-fir forest habitats. In contrast, many of the other primary prey species (Reynolds et al. 1992) have either limited distribution in goshawk habitat (e.g., blue grouse), or become unavailable during the winter period. Several species hibernate (e.g., chipmunks, mantled ground squirrel) or migrate (e.g., American robin, mourning dove, band-tailed pigeon). There is evidence that at least some goshawks in the Southwest winter on or near their breeding home range (P. Kennedy, unpubl. data; R. Reynolds, unpubl. data). Preliminary radio telemetry data for six goshawks on the Coconino National Forest, indicated that in the winter, goshawks continue to forage in ponderosa pine areas

centered around their nest sites and not in lower elevational habitats (e.g., pinon-juniper) (P. Beier, pers. commun.). If indeed most goshawks remain at higher elevations throughout the winter, it would be prudent to modify the Forest Service management strategy to better integrate the needs of tree squirrels, particularly those of the tassel-eared squirrel, to ensure

Habitat fragmentation requires bears to utilize larger land areas to meet habitat needs, resulting in larger average home ranges. Important seasonal food supplies may become inaccessible if cover in travel corridors is removed. The removal of protective cover or the isolation of food supplies results in decreased habitat value, which affects the total number of bears an area can support. Failure to consider bear population dynamics and habitat needs in the management of this species will inevitably lead to its decline, or even its loss, in fragmented habitats.

Removal of understory cover and lowered canopy cover, as called for in the MRNG, will degrade or render unusable large areas currently used by bears. Furthermore, the MRNG does not provide for travel corridors to connect key bear habitat components. In ponderosa pine forests, bear habitat is inherently fragmented because cover is not uniformly distributed. Widespread application of the MRNG will further reduce cover, which may extirpate black bears from much of Arizona's ponderosa pine forests and islands of mixed conifer interspersed within pine forests.

Cumulative Effects

Cumulative effects on the environment result from the incremental impact of proposed actions added to past, present and reasonably foreseeable future actions, within and adjacent to a given management area. These spatial and temporal effects can result

MRNG is being applied to forest conditions which are, in part, the result of cumulative effects of past and present grazing, timber, fire, recreation, wildlife and other management activities. Although a variety of factors influence forest conditions, the following discussion is limited to the cumulative impacts of timber harvest because of its important role in determining short- and long-term forest conditions. Also, most management activities resulting from implementation of the MRNG will consist of silvicultural treatments.

Significant levels of timber harvest began in Arizona when the railroads arrived in northern Arizona. Cline (1976) stated that in 1882, when the railroad arrived in Flagstaff, there were 600,000 railroad ties lying along the track route. The railroad companies were granted rights to all odd numbered sections for 40 miles on each side of the railroad. The timber rights on these sections were sold to timber companies and the first large scale timber harvests were on railroad lands (USDA Forest Service 1973). In

acres had been cut over. At this point, wildlife associated with mature and old growth forests with snags had lost a large proportion of their habitat.

The 1973 Coconino Timber Management Plan (USDA Forest Service 1973) reported that 55% of the timber volume was expected to come from trees 29 inches DBH and larger. Today, trees greater than 29 inches DBH are extremely rare on the Coconino. The 1973 plan called for a harvest well in excess of growth (calculated at 41 million board feet per year) by proposing an allowable cut ranging from 50.2-65.2 million board feet per year, from 1933 to 1982. During the same period, the rotation length was reduced from 200 years in 1923-1933, to 150 years in 1943-1953, and to 120 years after 1963. In 1973, the importance of snags was recognized and the Coconino reversed a policy which had called for cutting snags as a fire prevention measure.

As virgin timber was harvested, fewer mature and old growth trees remained. Gradually, stands became dominated by young (VSS 3) and mid-aged (VSS 4) trees. Snags were also greatly reduced. Sound snags were harvested for wood; other snags were cut down as potential hazard trees and removed as firewood. These snags were not replaced because of the reduction in snag recruitment trees. All these changes affected wildlife habitats.

Patton (1984) found that canopy cover above 60% provided good to excellent tassel-earred squirrel habitat. As an example of more recent changes in Arizona's forests, Ward et al. (1992) examined 1972 and late 1980s aerial photos of ponderosa pine forest on the North Kaibab Ranger District. From an analysis of 38,300 acres, Ward et al. (1992) found that stands with over 60% canopy cover comprised 34% of the area in 1972 and only 4% of the area in the late 1980s. This reduction in canopy closure, over an approximately 15 year period, is considered significant by the Department.

In an effort to address cumulative impacts of past, present and future management actions, wildlife biologists have developed models to predict changes in wildlife habitat capabilities over time. The Southwestern Region of the Forest Service has developed a computer model called RO3WILD to predict changes in wildlife habitat quality. In Arizona, only the Apache-Sitgreaves National Forests have consistently used this model.

The Department summarized the cumulative effects analyses for 40 sales on the Apache-Sitgreaves National Forests over a seven year period, from 1986 through early 1993 (Table 3). The summary addresses 278,287 acres on five Ranger Districts. The impacts are expressed in terms of changes in the Habitat Capability Index (HCI), which is an estimate of change in the capability of the habitat to support a given species. These model estimates can be used to obtain relative measures of change in habitat capability under different land management scenarios, such as timber harvest alternatives.

Table 3. Average Habitat Capability Index (HCI) change predicted for seven management indicator species by the RO3WILD model for 40 timber sales on the Apache-Sitgreaves National Forests, from 1986-1993.

	MANAGEMENT INDICATOR SPECIES						
	Goshawk	Spotted Owl	Abert's Squirrel	Merriam's Turkey	Black Bear	Pygmy Nuthatch	Red Squirrel
Acres Analysed	246,977	112,717	158,062	191,758	126,970	146,595	105,569
Average HCI Change[1]	-16	-16	-20	-2	+1	-23	-11

[1]This is the sum of each sale's HCI change multiplied by the acres analyzed for that sale, divided by the total number of acres.

Recent studies have shown that some wildlife species decline slowly to a habitat/population threshold and then decline precipitously to extinction (Lande 1987, Lamberson et al. 1992). Animals most likely to display this pattern are territorial species where at least one component of their habitat (e.g., nest sites) is fragmented. The population viability analysis (PVA) conducted for the goshawk population on the North Kaibab (Maguire 1993) (Appendix 4) indicated that a declining trend in habitat carrying capacity produces certain extinction in populations whose growth rates are otherwise stable or increasing (Maguire 1993:13). On the Apache-Sitgreaves, the RO3WILD model results suggested that over the last seven years, the capability of the habitat to support goshawks has declined 16% overall, which equates to a 2.3% per year loss in habitat carrying capacity. This rate of loss for the goshawk is roughly paralleled by losses in habitat capability for the spotted owl, Abert's squirrel, pygm. nuthatch and red squirrel (Table 3).

The RO3WILD models are far from perfect, but they do represent a sincere effort, by Forest Service biologists and others, to build a model which displays the impact of timber management. The RO3WILD model estimates declines in habitat quality on the Apache-Sitgreaves for a variety of species caused by timber harvest since 1986 (Table 3). Declines in habitat quality demonstrate the need to reevaluate management direction.

The changes in ponderosa pine habitats since timber harvesting began in Arizona, and RO3WILD model results, indicate there has been a decline in habitat quality for many wildlife species. Current forest conditions provide the setting in which potential additive impacts from implementing the MRNG will be realized. The Department believes that implementation of the MRNG, as currently written, will have adverse cumulative effects on many species

(e.g., tree squirrels) whose available habitat has already been degraded or has greatly declined.

Forest Land and Resource Management Plan Standards and Guidelines

In a letter to Forest Supervisors in the Southwestern Region dated September 16, 1992, the Deputy Regional Forester directed that the Interim Guidelines will take precedence over existing LMP Standards and Guidelines where conflicts occur between the two (Appendix 1). The justification for this direction was the status of the goshawk as a Forest Service sensitive species. In addition to questioning the anticipated benefits of the Forest Service management strategy for goshawks, the Department also believes that application of the MRNG may harm other sensitive species such as the flammulated owl and sharp-shinned hawk (see section on "Examples of Species-Specific Concerns").

Wildlife Standards and Guidelines in the LMPs were developed with full public involvement under NEPA to ensure that critical wildlife habitat components, such as snags for cavity-dependent birds and thermal and hiding cover for elk and deer are maintained on

National Forest lands. The Department believes that replacement of the Standards and Guidelines with the Interim Guidelines will not adequately address the needs of a variety of wildlife for which the Department has management responsibility.

For example, the number of snags which would be produced under the current Forest Service management strategy (see "Snag recruitment and longevity modeling" section of this document) will not meet the snag requirements of cavity-dependent birds addressed by LMP Standards and Guidelines (see "Cavity-dependent birds" section of this document). Although LMP Standards and Guidelines for thermal and hiding cover were designed primarily for deer and elk, they also satisfy the needs of other species and are an important component of wildlife habitat which is not considered in the MRNG.

The need for forest managers to consider deer and elk cover requirements in their management prescriptions is well recognized (Thill et al. 1983, Wisdom et al. 1986, Thomas et al. 1988, Schuster et al. 1985, Hoover and Wills 1987). While studying elk cover requirements in Arizona, Brown (1987) recommended 70%+ canopy cover for summer thermal cover to maintain high reproductive rates. Haywood et al. (1987) suggested deer selected areas with a high proportion of pine and very low (2.3%) proportion of meadows and recommended managing for 60% cover for deer on the North Kaibab.

Both deer and elk require thermal and hiding cover to ensure survival and high productivity. The Department believes that the thinning in VSS classes 2-6 called for in the Implementation Guidelines, will make it difficult to satisfy LMP Standards and Guidelines for hiding and thermal cover. There is a need to increase the range of densities in the VSS classes to provide this type of cover. In summary, the Department believes that wildlife Standards and Guidelines designed for species other than the goshawk, can be maintained while still providing appropriate protection for the goshawk.

WILDLIFE SCIENCE AND ITS APPLICATION TO THE FOREST SERVICE MANAGEMENT STRATEGY

This section reviews the MRNG in the context of wildlife science and its application. The MRNG was evaluated from two perspectives: 1) the process of obtaining and using scientific information, and 2) with respect to specific goals, principles, and assumptions involved in development and implementation of the MRNG.

The MRNG as Wildlife Science

Development and implementation of the MRNG followed an "inductive-deductive" approach (sensu Davis 1985), using pre-existing information to identify, select, and apply biological principles to the management of goshawk habitat. This approach is acceptable where immediate management decisions must be made and testing of an hypothesis is not practical. Since the approach is untested and involves considerable uncertainty, it must be capable of rapidly adjusting to new information and should be limited in the scope of its application to maintain future management options.

Thus far, the process has not involved direct application of the hypothetico-deductive (h-d) scientific method, wherein research hypotheses concerning patterns or processes of interest are identified and then tested with empirical data. Recent reviews of the practice of wildlife science have argued that the h-d method is the best means of obtaining reliable knowledge for use in management (Romesburg 1981, Murphy and Noon 1991). Application of the MRNG has far-reaching ecological implications, affecting forest habitats and wildlife throughout Arizona and New Mexico. Therefore, the MRNG must be based on wildlife science that is not only credible, but defendable and reliable.

The h-d method is typically associated with wildlife research, however, it can also be applied to management. Most management efforts are in reality, experiments based on ecological assumptions. If designed properly, these efforts can test the assumptions and provide valuable information (MacNab 1983). Murphy and Noon (1991:773) noted that many wildlife management situations have two characteristics that argue for the use of h-d methodology: 1) decisions are made with incomplete information, and 2) management plans and conservation strategies have properties that can be stated as hypotheses and tested with empirical data. A recent example of the use of h-d methodology in conservation planning was the development of a conservation strategy for the Northern spotted owl (Murphy and Noon 1991, 1992). A series of hypotheses concerning owl population dynamics and habitat use were formulated and tested with empirical data and simulation models. The end product was a habitat conservation plan that met rigorous scientific standards, specifying the size, forest structure, and distribution of habitat reserves.

The analytical procedures and reserve design criteria used to develop the Northern spotted owl conservation plan may or may not be appropriate to other species (such as the goshawk), however, the general approach is applicable (Murphy and Noon 1991, 1992). The management situation of southwestern goshawks meets the criteria proposed by Murphy and Noon (1991), i.e., available information on many aspects of goshawk biology is limited, as is our understanding of the responses of goshawk habitats to management (Reynolds et al. 1992:1). The MRNG contains a number of assumptions from which testable hypotheses could be developed. For these reasons, the Department feels that h-d methodology should play an important role in the further development, testing, and refinement of management [redacted]

[redacted]

The goal of the GSC was "... to develop a credible management strategy to conserve the goshawk in the southwestern United States"

ecosystem management approach to forest management, but does not equate the MRNG with ecosystem management. As discussed throughout this document, implementation of the MRNG will not adequately address the needs of many wildlife species. Because the landscape implications of the MRNG are also untested hypotheses, the Department does not feel that they should be applied to forest landscapes across Arizona without further analysis and adjustment.

Monitoring and evaluation were not directly addressed in the MRNG, except for the following statement: "... as our understanding of the goshawk and its habitat use and preferences increase, these management recommendations will be refined" (Reynolds et al. 1992:9). The Department agrees that an adaptive monitoring approach is appropriate, however, a formal framework is essential. Bailey (1982) observed that "... the most widespread failure of wildlife management in the U.S. is the lack of local testing of treatment efficacy." Without the appropriate monitoring, research and refinement called for in the MRNG, the MRNG will remain an untested hypothesis. Development of the MRNG required a tremendous investment in time and resources. This commitment must be carried through the application and evaluation phases. The Department will do all it can to assist in these efforts.

Conclusions

The Department believes that conservation and management of the goshawk and its habitats can best be achieved by a more rigorous application of scientific methodology. The MRNG provides a valuable starting point, testable hypotheses which may lead to a viable conservation strategy. The next essential step is a test of these hypotheses in well-designed "management experiments." Because of the uncertainty involved, this should be done on an incremental basis (i.e., on a subset of active goshawk territories). This will allow for modification as needed and also preserve future management options.

ARIZONA GAME AND FISH DEPARTMENT RECOMMENDATIONS

Introduction

The Department supports aspects of the MRNG, including longer rotations, more uneven-aged treatment on small areas, 6,000 acre territories for goshawk management and the intent to manage for more acres of large old trees. The Department also supports the continuation of timber harvest as a tool in forest management. However, the MRNG considered only the needs of the goshawk and 14 of its prey species. In this document, the Department has detailed its concerns for the species considered in the MRNG as well as a broad range of other wildlife. Following are the Department's recommendations for modifications to the Interim Guidelines and Implementation Guidelines. The Department believes that these modifications will correct deficiencies in the Forest Service management strategy for the goshawk and will resolve concerns regarding the habitat needs of other wildlife. These recommendations are not intended to provide the best possible habitat for the goshawk but are intended to provide an array of habitat conditions which should maintain the wildlife diversity of the ponderosa pine ecosystem, including the goshawk. The recommendations include 1) changes to the Implementation Guidelines and changes to the Interim Guidelines, and 2) monitoring and research needs.

Recommended Modifications to Implementation Guidelines and Interim Guidelines

1) Implement a minimum 250 year rotation age in goshawk management areas. Maintain a 20 year period between entries for timber harvest. This recommendation will require a change in the current Implementation Guidelines.

2) Revise the SDIs in the Implementation Guidelines as follows:

   Foraging Area:

   The intent is to maintain high variability. Point sampling may show a range of SDIs from near 0 to over 300. These extremes are both acceptable and desirable. Therefore, the Department recommends managing for a range of SDIs from 110-230, provided the SDIs are determined from an aggregate of points incorporating existing extremes. Manage for an even distribution of SDIs across this range.

   PFA:

   The intent again is to provide high variability but with a higher average SDI. Provide for a range of SDIs from 160-230, provided SDIs are determined from an aggregate of points. Manage for an even distribution of SDIs across this range.

3) Consistent with a 250+ year rotation, manage for a maximum of 8% of the 6,000 acre goshawk management area in regeneration (VSS 1). Manage for a minimum of 20% in VSS 5 and 20% in VSS 6. Where poor growing conditions (low site index) will not produce 20% VSS 6, retain all current trees over 24 inch DBH and substitute additional VSS 5 acres to provide a minimum of 40% in VSS 5 and 6.

4) The Interim Guidelines only replace the original LMP Standards and Guidelines for goshawks. All other wildlife S&Gs should be maintained unless amended pursuant to NEPA.

5) It is unnecessary to treat acres classified as unsuitable for timber harvest in the Forest Plans to benefit the goshawk.

6) Defer treatment of stands with old growth attributes until old growth inventories and allocations required by Forest Plans have been completed, then retain the integrity of those areas allocated to old growth.

7) Return to the original biological intent of VSS 5 and 6 rather than just using a diameter criteria. This requires adjustment in both the Implementation Guidelines and Interim Guidelines to include the biological attributes of older trees.

8) Emphasize uneven-aged management in Arizona's forests. The Department recognizes that control of forest pests and diseases, management of urban interface areas where fire management is important, and maintenance of some site specific wildlife habitat needs may best be accomplished through even-aged management. However, no more than 20% of a goshawk management area should be under even-aged management with maximum stand size of 100 acres.

9) Maintain a minimum of 5 reserve trees per acre to provide future snags and downed logs.

The Department believes that implementation of the Recommendations listed above will help to resolve concerns over snags, canopy cover, old growth, hiding and thermal cover.

Recommended Scope of Application

The Department recommendations are limited to the goshawk management areas. Although the Department believes that our recommendations will provide suitable habitat for a broad range of wildlife species, application of any management strategy on a landscape scale is inappropriate without a rigorous analysis of the potential impacts on all resources.

A management issue yet to be resolved is the provision of additional suitable habitat which would allow existing goshawk populations to be maintained or to expand, where appropriate. As

already identified in this document, the Interim Guidelines will not create suitable habitat outside goshawk management areas where goshawks can establish new territories. This is a significant management issue because 1) the state and federal wildlife agencies and the Forest Service have a responsibility to manage for viable wildlife populations, 2) after receiving proposals to list the goshawk under the ESA, the USFWS is conducting a status review, and 3) the Secretary of the Interior has advocated proactive management initiatives to avoid the need for listing under the ESA. Therefore the Department is recommending that the Goshawk Implementation Team develop a strategy to provide for expanding goshawk populations to insure their viability across the southwest.

Recommended Monitoring and Research

1) Identify areas in Arizona's forests which reflect the DFC identified in the MRNG. Monitor these areas and recent timber sales to see if goshawks and the 14 targeted prey have responded as expected and whether silvicultural objectives were met.

2) Monitor goshawk populations on at least one other area besides the North Kaibab Ranger District with different habitat attributes than those on the North Kaibab Ranger District. See the goshawk PVA in Appendix 4 for additional research and monitoring recommendations.

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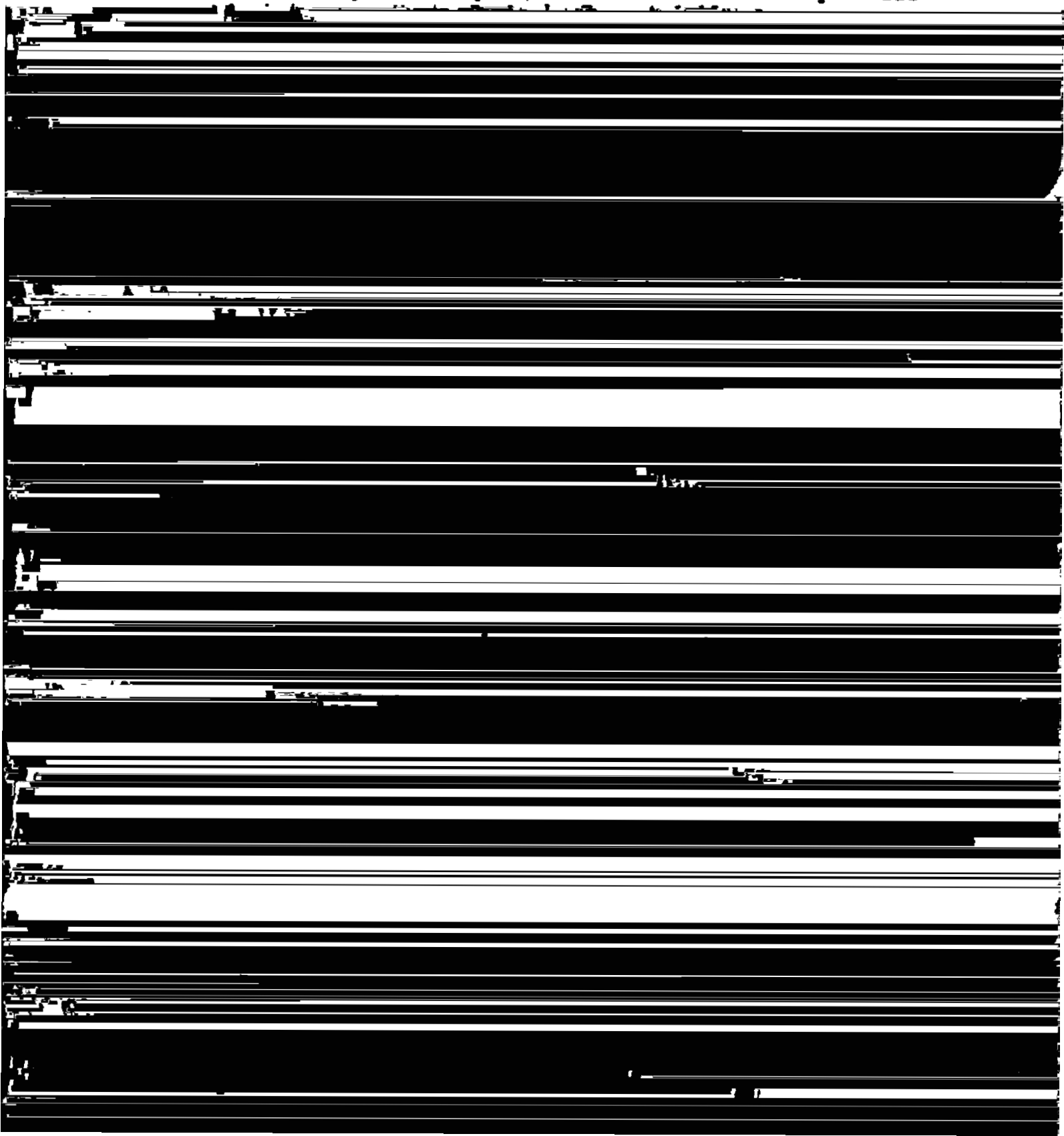

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